Africa RISING West Africa Project

2017/2018 Workplan

September 2017

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The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-in-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment. http://africa-rising.net/

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Contents

Outcomes, outputs and activities of the Africa RISING West Africa project Phase 2

Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.	
Output 1.1: Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners.	Activity 1.1.1: Test and disseminate a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production. Activity 1.1.2: Test and disseminate a combination of improved breeds, housing, feeding, health and breeding practices to intensify rearing of livestock (sheep, goat, pig, and poultry) for meat, egg and milk production. Activity 1.1.3: Test and disseminate integrated crop-livestock-soil and agroforestry systems to increase and sustain productivity and reduce risk.
Output 1.2: Integrated management practices and innovations to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated with farmers and development partners in the intervention communities.	Activity 1.2.1: Test and disseminate land, soil and integrated land-soil technologies and practices to improve and sustain productivity and ecosystems services at the farm and landscape/watershed levels. Activity 1.2.2: Test and promote water management technologies and practices to increase water productivity in the small-scale crop-livestock farming systems under rain fed and irrigated conditions. Activity 1.2.3: Test and promote integrated soil fertility and integrated pest management technologies and practices to increase and sustain productivity and reduce risk.
Output 1.3: Labor-saving and gender-sensitive technologies in target areas to reduce drudgery while increasing labor efficiency in the production cycle delivered.	Activity 1.3.1: Train local partners on appropriate use of drudgery-reducing technology delivery. Activity 1.3.2: Introduce, test and adapt existing pre-harvest small-scale mechanization options to farmers and partners in the intervention communities.
Outcome 2: More farmers and farm families are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling and value addition.	
Output 2.1: Improved technologies, innovations, practices and habits to increase production and consumption of safe diverse and more nutritious food for farm families, especially by women and children developed and disseminated in partnership with research and development partners.	Activity 2.1.1: Develop a nutrition strategy to harmonize the nutrition activities with national nutrition approaches and link them to the crop and livestock activities. Activity 2.1.2: Train farm families, especially women to produce and consume diverse and more nutritious food. Activity 2.1.3: Use nutrition focused activities as an entry point for greater involvement of younger women and the youth in the production and consumption of diverse and more nutritious foods.
Output 2.2: Postharvest technologies and practices to provide options for the food, and feed sectors are tested and disseminated to farmers, through researchers, extension staff, and development partners.	Activity 2.2.1: Introduce, evaluate, adapt and disseminate existing postharvest technologies and practices. Activity 2.2.2: Build capacity of farm families to reduce postharvest losses.

Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies.	
Output 3.1: Enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policy makers and development partners.	Activity 3.1.1: Review existing policies and institutional arrangements affecting equitable access to production assets and markets. Activity 3.1.2: Assess the level of inclusiveness of women and the youth along crop and livestock value chains. Activity 3.1.3: Advocate enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets.
Output 3.2: Options to expand accessibility of production assets and increase participation in house-hold decision-making by disaggregated groups by gender.	Activity 3.2.1: Identify constraints to, and opportunities for increasing women and youth access to production assets in the target area.
Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI, technologies, innovations and practices.	
Output 4.1: Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale.	Activity 4.1.1: Conduct cost-benefit and gender analysis coupled with other socio-economic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts. Activity 4.1.2: Map and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling delivery of validated technologies. Activity 4.1.3: Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways.
Output 4.2: Gender-sensitive decision support tools to assess technology-associated risks and opportunities are available for use by project partners.	Activity 4.2.1: Identify and communicate gender-sensitive decision support tools in the context of different farm typologies.
Output 4.3: An updated framework for monitoring technology adoption to be used by the project team and scaling partners available and accessible	Activity 4.3.1: Monitor and report technologies and their associated beneficiaries or farmers exposed to the innovations using the tools developed by IFPRI. Activity 4.3.2: Make these reports available on the Africa RISING repositories.
Output 4.4: Knowledge sharing centers (physical structures) and learning alliances are developed within existing local and regional institutions	Activity 4.4.1: Establish knowledge-sharing and learning alliances among scaling actors.

Ghana

Partners and their responsibilities

Name	Acronym	Role/responsibility
Government Ministries & Entities		
Ministry of Food and Agriculture	MoFA	Scaling-out SI technologies and establishment of R4D platforms
Ghana Health Services	GHS	Household nutrition R4D with UDS and IITA
Grains and Legumes Development Board	GLDB	Production of foundation seeds
Veterinary Services Division	VSD	Animal health and capacity building of community health workers
Women in Agriculture Development	WIAD	To improve lives and working conditions of rural households
Academic/National Research Institutions		
Animal Research Institute	ARI	R4D on livestock production (sheep and goats) with ILRI
Crops Research Institute	CRI	Breeder seed of improved cereals and legumes
Kwame Nkrumah University of Science and Technology	KNUST	Graduate student training and R4D on rural pig production
Savanna Agricultural Research Institute	SARI	R4D on cereal-legume-veg. systems with IITA, ICRISAT and WorldVeg
Soil Research Institute	SRI	R4D on integrated soil fertility management with IITA
Science and Technology Policy Research Institute	STEPRI	Policy and institutional research
University for Development Studies	UDS	Graduate training and R4D on rural poultry and pig production
Water Research Institute	WRI	Research on water management
Non-Governmental organizations & research institutions		
Adventist Development and Relief Agency (ADRA-Ghana)	ADRA	Scaling-up of technologies and linkages with community-based organizations
Association of Church-based Development NGOs	ACDEP	Scaling-up of proven technologies
Care Ghana	CARE	Dissemination of technologies
Canada Funds for Children	CFC	Dissemination of technologies and linkages with youth and women's groups
Catholic Relief Services	CRS	Dissemination of technologies

Grameen Foundation	Grameen	Promoting farmers' cooperatives and linking farmers to financial services
International Crops Research Institute for the Semi-arid Tropics	ICRISAT	Sorghum/millet-groundnut R4D with IITA and SARI
International Food Policy Research Institute	IFPRI	Lead site selection, baseline survey and monitoring and evaluation
International Institute of Tropical Agriculture	IITA	Overall project coordination and R4D research on cereal-legumes
International Livestock Research Institute	ILRI	Lead R4D on ruminants in Ghana and natural resources governance in Mali
Institute for Scientific and Technological Information	INSTI	Organize training and publish project document with IITA
International Water Management Institute	IWMI	Lead R4D on water management
Wageningen University and Research, The Netherlands	WUR	R4D on farming systems characterization and graduate training
Private organizations and development projects		
AMSIG Marketing Company	AMSIG	Linking farmers to markets
Agricultural Development & Value Chain Enhancement Program	ADVANCE II	Assist with market linkages, joint demonstration of technologies
Agricultural Technology Transfer Project	ATT	Assist with the introduction of new labor-saving technologies
Farm Radio International	FRI	Radio programs to disseminate technologies
Food Security Through Cooperatives in Northern Ghana	FOSTERING	Promoting farmers' cooperatives and linking farmers to financial services
Resilience in Northern Ghana Project	RING	Joint activities in nutrition and small ruminant production
Seed Producers Association of Ghana	SeedPAG	Production of certified seeds and training on seed production

Summary

The Africa RISING West Africa (WA) project is being implemented by multi-disciplinary research teams and development partners from the public and private sectors in collaboration with farmers and community-based organizations in northern Ghana and southern Mali.

This document presents the work plans for the 2017 research year for Ghana. The work plans are mapped under the four Outcomes in the Phase 2 project log frame (See Table 1 below). Nine activity protocols are presented – four for Outcome 1; two each for Outcomes 2 and 3; and one for Outcome 4. The nutrition activities are integrated with the livestock and vegetable activities in protocol GH211-17 under Outcome 2 in response to the recommendation of the USAID-commissioned external evaluation team.

Gender mainstreaming, capacity building and knowledge exchange and dissemination are embedded in all activity protocols. Linkages between activities are presented in each activity protocol. Publication of research results and better communication among research teams within and across countries will be a major focus.

Background

Phase 1 (1 October 2012 - 30 September 2016) of the USAID-funded Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) project in West Africa (WA) was implemented in 25 intervention communities in northern Ghana and 9 villages in the Bougouni and Koutialia districts of the Sikkaso Region in southern Mali under the *title 'Sustainable Intensification of Key Farming Systems in the Guinea-Sudano-Sahelian Zone of West Africa'*. Research activities under Phase 1 were organized around 3 research outputs (ROs), namely: 1) Situation analysis and program-wide synthesis (RO1); 2) Integrated Systems Improvement (RO2) and 3) Scaling and Delivery (RO3). Capacity building and gender were cross-cutting.

Phase 2 (1 October 2016 - 30 September 2021) of the WA project was launched in February 2017. The workplan is organized around 21 activities under 11 outputs to achieve four outcomes (Table 1). Implementation will be guided by achievements and lessons from Phase 1. There will, however, be a shift in approach from Research-for-Development (R-4-D) in Phase 1, to Research-in-Development (R-in-D) in Phase 2.

Technological packages and/or practices validated in Phase 1 (see Table 1) will be scaled out targeting agro-ecosystems and socio-economic circumstances defined by the sustainable intensification (SI) domains - productive, economic, social, human and environmental. Linkages will be established with research and development partners to undertake both generic and back-stopping research. The generic research aims at completing the loose ends of research on the SI innovations in Phase 2 plus any other emerging issues. The back-stopping research will address researchable issues emerging from the scaling-out of SI innovations with the development partners.

Phase 2 will also explore new research areas emerging from Phase 1 experiences and feedback by research and development partners, notably, using results from farming systems analyses and farm types to inform research targeting and technology dissemination; post-harvest management and value addition; nutrition sensitive agriculture; labour-saving

mechanization solutions for small-scale farmers; and climate-smart agriculture. The project will also develop the following research and development strategy documents: 1) a livestock strategy to increase the impact of livestock-related activities, especially those on small ruminants, poultry and pigs; and a nutrition strategy to harmonize nutrition-related activities with the crop and livestock activities, as well as with national nutrition approaches. It will engage in purposeful inclusion of gender and youth concerns; and develop more rigorous and quantitative approaches for measuring diffusion and early adoption of SI technologies.

This document presents the work plan for Ghana for the 2017 research year. The work plan for Mali for the same period is presented in a separate document.

Table 1: List of validated technologies ready for promotion through development partners in the Northern, Upper East and Upper West regions of Ghana

Broad category	Validated flagship technology
Introduction of new crops and varieties to overcome existing biotic and abiotic stresses and improve productivity per unit land area	New varieties – drought tolerant maize, rice, aflatoxin resistant groundnut, sorghum hybrids, early-maturing cowpea, dual-purpose cowpea, short-duration soybean, medium soybean, high yielding and disease resistant varieties of vegetables (okra, roselle, tomato, eggplant and pepper)
Agronomic practices to improve grain and fodder yield per unit land area, and improve soil nitrogen	Cereal-legume intercropping Cereal-legume rotations Dual-purpose food legumes Cereal-vegetable intercropping
Integrated soil fertility management as a cost-effective approach to replenish soil fertility	Optimized N and P fertilizer rates Fertilizer micro-dozing Livestock corralling for manure/urine Cereal-legume rotations Cereal-legume intercropping
Improved livestock feeds and feeding, housing, health and breeding management packages	Sheep/goat flock feeding package Sheep/goat health package Housing and feeding for poultry Guinea fowl hatching and brooding management Stover quality improvement
Introduction of pre- and post-harvest technologies to reduce food waste and improve food safety	Storage – PICS bags, plastic drums Aflasafe application

Planned work

The planned activities are presented in the protocols. Activities under each protocol are aimed at achieving the outputs under the four outcomes in the project log frame (Table 1).

2017 Africa RISING West Africa Activity Protocol – Outcome 1: GH111A-17	
Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets.	
a. Output: 1.1	Research will identify more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems and will disseminate these to the farmers through development partners in the intervention communities
b. Activity: 1.1.1	Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production
c. Sub-activity: GH111A-17	Test, disseminate and adapt crop, livestock and integrated crop-livestock technologies and practices to increase and sustain productivity of smallholder crop-livestock farming systems

d. Research team

Name	Institution	Role
Asamoah Larbi	IITA	Leader, crop-livestock systems, graduate training
Abdul Rahman Nurudeen	IITA	Cereal agronomy and plant nutrition
Bekele Kotu	IITA	Economic analysis
Shaibu Melon	IITA	Economic analysis
Gundula Fischer	IITA	Gender studies
Kipo Gimah	IITA	Gender studies
Kofi Danso	IITA	Post-harvest management
Terry Ansah	UDS	Ruminant nutrition
Adda Wesseh	UDS	Livestock nutritionist
Saaka Buah	SARI	Plant nutrition and soil science
Jean-Baptiste Tignegre	WorldVeg	Vegetable breeding
Zakaria Iddrisu	SeedPAG	Seed production and training
Robert Asuboah	GLBD	Foundation seed production
Obeng Asamoah	CRI	Breeder seed production
Samuel Partey	CCAFS/ICRISAT	Climate change adaptation and mitigation
Mathieu Ouedraogo	CCAFS/ICRISAT	Participatory action research - climate change
Robert Zougmoré	CCAFS/ICRISAT	Agronomy and soil research
Baloua Nebie	ICRISAT	Sorghum and millet agronomy
Aboubacar Toure	ICRISAT	Sorghum and millet agronomy

e. Student(s)

Name	Institute	Degree	Start	End

f. Location(s)	Northern (Tingoli, Cheyohi no. 2, Doku, Tibali), Upper East (Samboligo, Nyangua, Gia, Bonia), Upper West (Zanko, Guo, Goli, Goriyiri) regions
g. Start	June 2017
h. End	March 2018

1. Justification

Small-scale crop-livestock farming systems predominate in the intervention communities of the Africa RISING project in the three northern regions of Ghana. Farmers grow cereals (e.g., maize, rice, millet and sorghum), legumes (e.g. groundnut, cowpea, soybean, Bambara, pigeon pea) and vegetables (roselle, okra, pepper onion, garden egg, tomato, amaranths, pumpkin) in pure or mixed stands. They raise livestock (cattle, sheep, goats, pigs and poultry) under extensive and semi-intensive systems for meat and milk for food, manure for crop production, cash, power for land cultivation and transport, with limited feed, shelter, health care, and breeding management. Total productivity of the integrated crop-livestock systems is generally low, partly due to weak integration of the crop and livestock enterprises and limited use of good agronomic and animal husbandry practices.

Crop yields on farmers' fields are generally poor due to low and variable rainfall, drought, low and declining soil fertility, use of low yielding varieties, lack of quality seed of improved crop varieties and land preparation equipment, high cost of inputs and postharvest losses, labour constraints that lead to poor growing conditions (late sowing, sub-optimal plant populations, inadequate control of weeds, *Striga*, pests and diseases), and low use of organic or mineral fertilizers. Productivity of the animals is low due to inappropriate husbandry (feeding, health care, housing, and breeding) practices that result in high mortality rates. Farmers have limited access to veterinary services, and improved livestock breeds. Fallow land grazing and crop residues are the main feed resources for the livestock. Due to high human and livestock populations, fallow lands are overgrazed leading to degradation of the land, soil and vegetation resources.

In Phase 1, several interventions were tested in partnership with multiple partners including farmers and community-based organizations using the technology park approach. They included: testing and dissemination of improved crop varieties (drought and striga resistant, high yielding, short/medium/long duration multi-purpose crops); appropriate agronomic (planting density, cereal-legume-vegetable intercropping, crop diversification, and agro forestry) and animal husbandry (semi-intensive and intensive management, dry season feed supplementation, vaccination and deworming) practices, and ensuring better integration of the crop and livestock enterprises. Group and individual trainings and short courses were used to strengthen the capacities of the partners. Academic trainees at MSc and PhD levels were engaged to address important knowledge gaps and to build national research capacity. Limited studies were conducted to examine effects of cropping technologies on soils (nutrient depletion) and the interactions among soils, crops and livestock; simulation via crop-processed models to address systems stability and trade-offs, and production variability and risk assessment.

This protocol addresses crop-livestock-vegetable related issues in the Africa RISING West Africa Phase 2 project logframe, especially Activities 1.1.1, 1.1.2 and 1.1.3 (Table 1). The research activities for 2017 within this protocol focus on developing good agronomic practices to maximize production of food and feed from cereal-legume systems. The activities are: 1) variety and planting density effects on grain and fodder yield and quality of groundnut, and 2) leaf stripping to optimize grain and feed from maize-based cropping systems, 3) cowpea living mulch effect on weed control, soil properties and maize yield, 4) agronomic practices to maximize aflasafe use in maize and groundnut cropping systems, 5) intensifying and diversifying rainfed and irrigated vegetable production, and 6) Climate Smart Village approach to mainstream climate variability in the promotion of sustainable intensification innovations.

In response to the recommendations of the USAID-commissioned external evaluation team, Decision Support Systems will be used to match the agronomic technologies (fertilizer application, crop densities, planting dates, crop combinations) to soil and climatic conditions for sustainable intensification of the cropping systems, and to address production variability and risk in northern Ghana. Knowledge transfer and scaling strategies will include: establishment of research-for-development plots to demonstrate technologies; participatory and joint learning approaches for technology testing, e.g., Community-based Technology Parks; development of media materials (posters, leaflets, films) for extension staff, farmers, etc.; organize exchange visits for farmers and researchers; training of trainers and hands on training for farmers. Activities planned under this protocol relate to activities RT2-Gh-1 and RT2-Gh-2 of the 2015-2016 research year work plan under Phase 1.
Sub-activity GH111A-1701: Variety and planting density effects on grain and fodder yield and quality of groundnut - Leader: Asamoah Larbi
Groundnut is the most important food and feed crop in West Africa. Grain and fodder yields are low due to limited use of improved varieties and inappropriate agronomic practices such as low planting densities. Consultations by the Groundnut Scaling and N2 Africa projects show that farmers use different planting densities for most of the improved varieties released over the past decade. Secondly, fodder yield and quality were not considered as selection criteria in the breeding programs. Therefore, a study was started in 2016 to test the hypothesis that variety and planting density significantly affect grain and haulm yields and quality, and weed population in fields of released groundnut varieties in northern Ghana.
2. Objectives
2.1 Determine the effect of plant density on groundnut yield
2.2 Evaluate adaptability and suitability of improved groundnut varieties to different agro-ecologies
2.3 Evaluate the effect of gender on yield of groundnut
2.4 Evaluate the effect of groundnut variety and plant density on the quantity and quality of groundnut fodder
3. Research questions
3.1 How do different plant densities affect yields of groundnut?
3.3 How do improved groundnut varieties adapt to the different agro-ecologies?
3.4 How does gender affect groundnut yield?
3.5 How do feeding residues of different groundnut varieties to small ruminant affect their growth performance?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
The effect of 4 plant spacing (30 x 15, 45 x 15, 60 x 15, 75 x 15 cm) on grain and haulm yield of seven groundnut varieties (Chinese, Azivivi, Obolo, Yenyawoso, Manipinta, Samnut 22, Samnut 23) will be evaluated using a 4 x 7 factorial arrangement in a randomized block design in the technology parks and on selected farmers' field. A gender survey will be conducted to evaluate male and female preferences. Farmers' field day will be organized. Cost benefit analysis will be compared. The haulms will be analyzed for crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and in vitro organic matter digestibility (IVOMD). A feeding trial will be conducted on-farm and on-station with 6-10 sheep or goats per treatment to determine voluntary intake and growth performance.

5. Data to be collected and uploaded	Responsibility
5.1 Grain and haulm yield	IITA
5.2 Access to labor, timing and frequency of farm operations, decision making at farm level	IITA
5.3 Determinants of fodder quality (CP, NDF, ADF), intake, digestibility, growth performance	UDS

6. Milestones		
Deliverables	Means of verification	End date
6.1 Agronomic trial completed	Field visit and project report	Dec. 2017
6.2 Gender survey conducted	Field visit and project reports	Dec. 2017
6.3 Feeding trial completed	Reports and project publication	Mar. 2018
6.4 Paper published: Variety and plant spacing effects on groundnut grain and fodder yields	Field Crops Research	Mar. 2019

7. Sustainable intensification indicators	
7.1 Productivity	Crop and livestock production at the plot and farm level
7.2 Environmental	Vegetative cover and cropping intensity at plot level
7.3 Economic	Profitability and input use efficiency at field and farm levels
7.4 Social	Gender equity at farm and household levels
7.5 Human	Food production and nutritious food production at plot and farm levels

Sub-activity GH111A-1702: Leaf stripping to maximize food and feed yields from maize-based cropping systems - Leader: Asamoah Larbi

Feed shortages during the cropping season constrain cattle, sheep, goat and pig production in small-scale crop-livestock systems. The lower leaves of cereals, especially maize can be stripped after tasseling or silking to provide feed during the cropping season without compromising the grain yield. The effect of stripping may vary with the maize maturity type. Quantitative information on such practice in northern Ghana and West Africa is limited. This study was started in the 2016 research year, second year data is required to confirm the first-year results.

2. Objectives

2.1 Determine the effect of leaf stripping on grain and fodder yield of maize

2.2 Evaluate gender preferences for leaf stripping

2.3 Determine the feed value of stripped maize leaves

3. Research questions

3.1 How does leaf stripping and maize maturity type affect grain and fodder yields?

3.3 What are gender preferences for maize leaf stripping?

3.4 How does the maize maturity type affect the quality of stripped leaves?

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)

The effect of three levels of maize leaf stripping (no stripping, stripped at 50% tasseling and stripped at 50% silking) and maize maturity type (Extra-early: TZEE-W STR QPM C0; Early, Omankwa; Medium, Obatanpa) on grain and fodder yields of maize will be determined using a 3 x 3 factorial treatment arrangement in a randomized block design in the community-based technology parks and on selected

farmers' fields. A gender survey and farmers' field day will be conducted to evaluate male and female preferences.

The fodder will be analyzed for crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and in vitro organic matter digestibility (IVOMD). A feeding trial will be conducted on-farm and/or on-station with either sheep or goats to determine voluntary intake and growth performance.

5. Data to be collected and uploaded	Responsibility
5.1 Grain and haulm yield	IITA
5.2 Access to labor, timing and frequency of farm operations, decision making at farm level	IITA
5.3 Determinants of fodder quality (CP, NDF, ADF), intake, digestibility, growth performance	UDS

6. Milestones

Deliverables	Means of verification	Date
6.1 Agronomic trial completed	Field visit and project report	Dec. 2017
6.2 Gender survey conducted	Field visit and project reports	Mar. 2018
6.3 Feeding trial completed	Reports and project publication	Mar. 2018
6.4 Paper: Leaf stripping effects on maize grain and fodder yields	Experimental Agriculture	Mar. 2019

7. Sustainable intensification indicators

7.1 Productivity	Crop and livestock production at the field and farm levels
7.2 Environmental	Vegetative cover, plant biodiversity and soil health at the plot level
7.3 Economic	Profitability and input use efficiency at the plot and farm levels
7.4 Social	Gender equity at the farm and household levels
7.5 Human	Food production and production of nutritious food at the field and farm levels

Sub-activity GH111A-1703: Cowpea living mulch effect on weed control, soil properties and maize yield - Leader: Asamoah Larbi

Maize (*Zea mays* L.) is a major cereal crop in West Africa, accounting for slightly over 20% of the gross domestic production in the sub-region (Manyong et al., 2000[1]). Grain yields on farmers' fields are low due to several biophysical and socio-economic factors, including low and erratic rainfall, low soil fertility, and weed infestation. Living mulch of legumes conserve nitrogen in grain crops, reduce soil erosion and weed pressure, and increase soil organic matter(Hartwig and Ammon, 2002[2]). This study was planned to start during the 2015-2016 research year to test the hypothesis that cowpea living mulch can significantly improve soil properties, reduce weed infestation, and increase maize yield under the Guinea-Sudano savanna conditions of West Africa. However, it could not be implemented due to the late start of the rains.

2. Objectives

2.1 Determine the effect of cowpea living mulch on weed population in a maize-cowpea cropping system

[1] Manyong V. M., Kling, J G., Makinde K. O., Ajala S. O, Menkir, A., 2000. 'Impact of IITA-improved germplasm on maize production in West and Central Africa'. *Impact*, IITA, Ibadan, Nigeria, pp.13.
[2] Hartwig N.L. and Ammon H.U. (2002). Cover crops and living mulches. *Weed Science, 50*(6), pp. 688-699.

2.2 Evaluate the effect of cowpea living mulch on soil properties in a maize-cowpea cropping system
2.3 Determine the effect of cowpea living mulch on maize grain and fodder yields
2.4 Evaluate the effect of gender on yield of maize under cowpea living mulch
3. Research questions
3.1 How does cowpea living mulch affect weed control under maize production?
3.3 How does cowpea living mulch affect soil moisture and temperature?
3.4 How does cowpea living mulch affect maize yield?
3.5 What are the preferences of male and female farmers for living mulch?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1 Agronomic design: Randomize complete block design (RCBD)
4.2 Gender: Survey
4.3 The effect of four levels of cowpea living mulch (No living mulch, cowpea and maize same day, cowpea one week after maize, Cowpea two weeks after maize) and maize maturity type (Extra-early: TZEE-W STR QPM C0; Early, Omankwa; Medium, Obatanpa) on weed control, soil characteristics and grain yields of maize will be determined using a 4 x 3 factorial treatment arrangement in a randomized block design. Trials will be conducted with farmers in the community parks and on selected farmers' fields. A gender survey and a farmers' field day will be conducted to evaluate male and female preferences.

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Weed diversity and biomass, maize grain and fodder yields	IITA
5.2 Gender: access to labor, timing and frequency of farm operations, decision making at farm level	IITA
5.3 Soil characteristics (temperature, moisture, nutrients)	SRI

6. Milestones		
Deliverables	Means of verification	Date
6.1 Agronomic trial completed	Field visit and annual reports	Dec. 2017
6.2 Gender survey report	Field visit and annual reports	Dec. 2017
6.3 Paper published: Cowpea living-mulch effects on maize grain yield, vegetation cover and soil moisture dynamics	Paper in peer reviewed workshop proceeding	Mar. 2019

7. Sustainable intensification indicators	
7.1 Productivity	Crop yield and the plot level
7.2 Environmental	Vegetative cover and soil health at the plot level
7.3 Economic	Profitability and input use efficiency at the plot and farm levels
7.4 Social	Gender equity at the farm and household levels
7.5 Human	Food production and nutritious food production at plot and farm level

Sub-activity GH111A-1704: Intensify and diversify irrigated smallholder vegetable production systems - Leader: Jean-Baptiste Tignegre
Rainfed and dry season irrigated vegetable (pepper, eggplant, and tomato) production in pure and/or mixed cereal-vegetable stands for food and cash are widespread in the intervention communities in Ghana. Limited access to seeds of improved varieties, water for dry season irrigation and information; and inappropriate agronomic practices (seeding rate, fertilization, disease control, pest management, etc.) are among the major constraints to production. Vegetable research in Phase 1 focused on limited varietal evaluation and assessment of various maize-vegetable cropping systems with limited community involvement. In Phase 2, varieties of known and little-known vegetable species and good agronomic practices will be evaluated under rainfed and irrigation conditions with farmers' interest groups in the Upper East and Northern regions. The vegetable activities will be related to the livestock and nutrition activities through promotion of home gardens to improve household dietary diversity and income (See protocol GH211-17). Activities planned under this protocol are related to activity RT2-Gh-3 in the 2015-16 research year work plan of Phase 1.
2. Objectives
2.1 Evaluate varieties of known and little-known vegetable species under rainfed and irrigated conditions with farmers
2.2 Evaluate good agronomic practices to intensify and diversity the small-scale rainfed and irrigated vegetable production
2.3 Promote information and knowledge exchange among farmers
3. Research questions/hypotheses
3.1 Leaf and/or fruit production of varieties of known and little-known vegetable varieties will not differ significantly under rainfed and irrigation conditions.
3.2 Good agronomic practices can significantly increase leaf and/or fruit yield of varieties of known and little-known vegetable species under rainfed and irrigated conditions.
4. Procedures
Sub-activity GH111A-1704-1: Identification of varieties of vegetable species adapted to northern Ghana under rain fed and irrigation - Leader: Jean-Baptiste Tignegre
In the dry season, about 3 to 4 trials will be conducted at the Vegetable Hubs in the Upper East and Northern regions and on selected farmers' fields to test 5 to 10 varieties of tomato, pepper, African eggplant and onion to select high-yield and disease resistant varieties. A randomized block design with 4 to 6 replications will be used. Separate trials will be conducted for varieties of each species using farmers' variety will be used as control. Field days will be organized to document male and female farmers' preferences for the various treatments.
Sub-activity GH111A-1704-2: Leaf and fruit production of vegetable varieties under different N regimes and irrigation system - Leader: Jean-Baptiste Tignegre
A 3 (tomato varieties - farmers' and two improved varieties) x 3 (N fertilizer applied as urea at 0, 30 and 60kg/ha) factorial treatment arrangement in a randomized complete block design with 3-4 replications will be conducted in the six Vegetable Hubs and farmers' fields. Separate trials will be conducted under drip irrigation. Similar trials will be conducted with pepper and African eggplant under drip irrigation. Field days will be organized to document male and female farmers' preferences for the various treatments. Farmers involved in the nutrition-sensitive agriculture activities (livestock + vegetable + nutrition) will benefit from varietal tests as home gardens.

5. Data to be collected and uploaded	
5.1 Days to 50% flowering	WorldVeg
5.2 Number of plants bearing fruits per plot; fruit yield (kg/ha)	WorldVeg
5.3 Leaf yield	WorldVeg
5.4. Gender preferences for vegetable varieties	

6. Milestones		
Deliverables	Means of verification	Date
6.1 Field trials established	Field visit and project reports	Aug. 2017
6.2. Database on vegetables	Uploaded on CKAN	Dec. 2017
6.3 Field days organized	Field visit and project report	Dec. 2017
6.4. Paper in workshop proceedings on Performance of vegetables varieties under irrigation'	Paper available online or in a proceeding	Dec. 2018

7. Sustainable intensification indicators	
7.1 Productivity	Crop yield and cropping intensity at the plot and farm levels
7.2 Environmental	Ground cover and water productivity at the plot level
7.3 Economic	Profitability and input use efficiency at the plot and farm levels
7.4 Social	Gender equity at the farm and household levels
7.5 Human	Nutritious food production at the plot and farm levels

Sub-activity GH111A-1705: Climate Smart Village approach to mainstream climate variability in the promotion of sustainable intensification innovations - Leader: Mathieu Ouedraogo

Promotion of Climate Smart Agricultural (CSA) practices remains a global developmental agenda and one mainstream opportunity to mitigate climate change and sustain the productivity of agricultural systems. Considering this need, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) has developed the Climate-Smart Village (CSV) approach as a means to agricultural research for development (AR4D). It is an approach where CCAFS in partnership with rural communities and other stakeholders (NARS, NGOs, local authorities), tests & validates in an integrated manner, several climate-smart agricultural interventions that will be brought to scale. The CSV approach is founded on the principles of participatory action research for grounding research on appropriate and location/context-specific enabling conditions, generating greater evidence of CSA effectiveness in a real-life setting and facilitating co-development of scaling mechanisms towards landscapes, sub national and national levels. The CSV approach has six components - (1) CSA practices and technologies, (2) climate information services and insurance, (3) local and national public and private institutions, (4) national and sub national plans and policies, (5) farmers' knowledge and (6) climate and ag-development finance. Each of the components involves members of the research team, meteorological services, local authorities and selected development partners. Since 2011, CCAFS has been using the CSV approach in West Africa (Ghana, Senegal, Mali, Niger and Burkina Faso) to test and validate several agricultural interventions with the participation of various local partners. In Ghana, substantial successes have been achieved over the past 4 years where through the CSV, climate information was used as an entry point for informing the choice of CSA technologies that have contributed to improved farm productivity and building resilient livelihoods for poor and marginal farmers. These successful technologies and practices include crop rotation (maize and cowpea), water conservation techniques (tie ridge), minimum or no tillage (with soybean and maize), application of combined mineral and organic fertilizer and use of drought tolerant varieties of crops.

In view of the priorities of Africa RISING, CCAFS will use its experiences in promoting and disseminating integrated crop-livestock-soil systems based on local climate variability for sustained productivity and reduced risk in the intervention communities.

2. Objectives		
2.1 Assess the local need for CSA based on climate, soil, crop, livestock and socio-economic factors		
2.2 Promote the use of climate information as a basis for farm management decisions		
2.3 Promote the adoption of CSA technologies and practices based on local needs for improved adaptive capacity to climate change and variability		
2.4. Strengthen the capacity of farmers and extension agents in climate smart agriculture		
3. Research questions		
3.1 What climate, soil, production and socio-economic factors inform the choice and use of the local agronomic practices?		
3.2 How does provision and use of climate information services relate to farm productivity and livelihoods of smallholder farm communities based on choice of climate-smart crop varieties, livestock breeds, fodder species and agronomic and animal husbandry practices?		
3.3 What factors constrain use and adoption of climate-smart crop varieties, livestock breeds, fodder species and farm practices (agronomic and animal husbandry) even with access to climate information services?		
3.4 What combinations of climate-smart crop varieties, livestock breeds, fodder species and farm practices enhance the adaptive capacity of farmers?		
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)		
4.1 Baseline assessment of farmers' vulnerability to climate risk and variability and their adaptation strategies to climate risk and variability. This will be followed by participatory identification and prioritization of climate-smart technologies, practices and services based on biophysical, socio-economic, gender, policy and institutional context; also considering possible synergies and trade-offs amongst individual activities. Thereafter, climate information services will be provided to farmers using climate forecast communication and the PICSA approach. Portfolios of climate-smart interventions (e.g. providing value-added weather services to farmers, building capacity in climate change adaptation and facilitating community partnerships for knowledge sharing) will then be evaluated. Capacities of stakeholders for the scaling up of climate-smart interventions through policies and institutions will be built and scaled out to large areas through farm-to-farm approach.		
5. Data to be collected and uploaded		
5.1 Socio-economic data (household livelihoods means, adaptation strategies, farmers' perceptions) will be collected at household and community levels by CCAFS in partnership with SARI.		
5.2 Historic weather information will be collected throughout the study		
6. Milestones		
Deliverables	Means of verification	Date
6.1 Local need of CSA based on climate, soil, crop, livestock and socio-economic factors assessed	Baseline assessment report	Apr. 2017
6.2. Farmers and extension agents trained in climate change and CSA	Training workshop report	Dec. 2017
7. Sustainable intensification indicators		
7.1 Productivity	Crop yield at household level	
7.2 Environmental		
7.3 Economic	Profitability and income diversification at the household level	
7.4 Social		

7.5 Human	Social cohesion at the community level

8. How will scaling be achieved?
Scaling will be achieved through strategic partnership with development partners. Knowledge transfer and scaling strategies will include: establishment of research-for-development plots to demonstrate technologies; participatory and joint learning approaches for technology testing, e.g., Community-based Technology Parks; development of media materials (posters, leaflets, films) for extension staff, farmers, etc.; organize exchange visits for farmers and researchers; training of trainers and hands on training for farmers.
9. How are the activities in this protocol linked to those of others?
Activities have links with those on vegetable and livestock production under protocol numbers: GH121-17, GH122-17 and GH221-17

10. Budget (USD)				
Budget Line	IITA	MOFA	WorldVeg	ICRISAT
Personnel	140,000	2,000	12,000	2,000
Services	120,000	6,000	4,000	6,000
Supplies	90,000	0	6,000	
Capital	0	0	2,000	
Travel	30,000	2,000	1,000	
Overhead	0	0	5,000	2,000
Total	380,000[1]	10,000[2]	30,000[3]	10,000[4]

[1]Includes cost of staff, project offices, vehicle running and maintenance of the 25 intervention communities in the Northern (Tamale), Upper West (Wa) and the Upper East (Navrongo) regions.
[2] Allocated by IITA to MOFA
[3]Amount for vegetable activities in the vegetable hubs in the Upper East (6) and Northern (1 hub)
[4]Allocated to CCAFS for climate-smart agriculture activities through ICRISAT allocation

2017 Africa RISING West Africa Activity Protocol – Outcome 1: GH111B-17	
Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets.	
a. Output: 1.1	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities
b. Activity: 1.1.1	Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production
c. Sub-activity: GH111B-17	Finalize efficacy trials of aflasafe products used in maize and groundnut and continuation of aflasafe carry-over efficacy trials and registration of two aflasafe products with Ghana-Environmental Protection Agency for use in Ghana at scale

d. Research team		
Name	Institution	Role
Ranajit Bandyopadhyay	IITA	Guidance
Alejandro Ortega-Beltran	IITA	Management and reporting

Richard Awuah	KNUST	Guidance		
e. Student(s)				
Name	Institute	Degree	Start	End
1 Daniel Agbetiameh	KNUST	PhD	2014	2018
2				
3				
f. Location(s)	Northern Region			
g. Start	August 2017			
h. End	September 2018			

1. Justification

Use of aflasafe is a proven technology to both displace aflatoxin producers in the field and reduce crop aflatoxin content. Aflatoxin contamination is thus reduced before, during, and after harvest, until consumption. In order to have aflasafe GH01 and aflasafe GH02 registered with Ghana's EPA, it is necessary to finalize the field efficacy trials conducted in 2016. It is expected to finalize analyses by September-October 2017. In addition, in order to optimize the aflasafe technology, it is necessary to determine the frequency of application, persistence of atoxigenic aflasafe strains in treated soils, and the carry-over of atoxigenic strains from one season to the next. During 2017, the third and final year of the carry-over study will be conducted. This investigation has been conducted in the past two years and needs to be finalized in the 2017 cropping season.

In order to have aflasafe products available for use at scale throughout Ghana, both aflasafe GH01 and aflasafe GH02 need to be registered with the Environmental Protection Agency (EPA) of Ghana. Data from efficacy trials conducted during 2015 and 2016 in both maize and groundnut fields will be summarized, analyzed and used to prepare a registration dossier for each product. By the end of 2017, the dossier will be submitted to EPA. Once achieving registration, a commercialization strategy for both products will be designed by IITA's aflasafe Technology Transfer and Commercialization Project.

The activities under this protocol are related to Activity RT5-Gh-3 in the 2015-16 research year work plan.

2. Objectives

2.1 To finalize analyses of field efficacy trials for preparation of dossier for registration of two aflasafe products for use in Ghana, in both maize and groundnut

2.2 To develop guidelines indicating mode and frequency of application of aflasafe products in each region and cropping system

2.3 To prepare a dossier for registration of aflasafe GH01 and aflasafe GH01 with the Environmental Protection Agency of Ghana

3. Research questions

3.1. Are aflasafe products effective in both displacing aflatoxin-producers in treated fields and decreasing crop aflatoxin content?

3.2 How often do farmers need to treat their fields with aflasafe to achieve aflatoxin-safe crop? Do atoxigenic strains composing aflasafe displace toxigenic fungi in treated fields and limit aflatoxin contamination?

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)

Sub-activity GH111B-1701: Finalize efficacy trials of aflasafe products used in maize and groundnut and continuation of aflasafe carry-over efficacy trials - Leader: Alejandro Ortega-Beltran

Chemical (toxin) analyses of samples from the field efficacy trials have been completed during the last portion of the year 2016. Microbial analyses of fungal communities associated with treated an un-treated crop is on-going and results will be ready by July-August 2017. Then, data will be summarized, analyzed and used to prepare the dossier for registration of both products with Ghana's Environmental Protection Agency. Visits will be conducted to both public and private sector organizations willing to include aflasafe into their package of activities to improve the maize and groundnut value chains. Staff of these organizations will be sensitized on the potential benefits of aflasafe and training workshops conducted to train trainers on aflatoxins and its management through use of aflasafe, and who will in turn train farmers under these organizations.

A three-year experiment to determine carry-over potential of strains of aflasafe GH01 and aflasafe GH02 is being conducted in the Ghana's Northern Region. 2017 will be the final trial year and results from this study will allow determining the frequency of application of both aflasafe GH01 and aflasafe GH02. A total of 120 maize fields will be used during the final year. For each aflasafe product, 60 maize (farmers') fields in a randomized complete block design of six treatments with 10 replications (fields)/ treatment will be used. In treatment 1, fields will be treated in alternate years with aflasafe within the period of the experiment. In treatment 2, fields will be inoculated consecutively in all three growing seasons. Fields in treatment 3 will be inoculated only in the first and second growing season while in treatment 4, field application will be carried out only in the first growing season. Fields in block 5 were not treated in the first two cropping seasons but will be treated only in the third and final year. Fields in block 6 will serve as control with none of the fields inoculated throughout the study period. Field soil samples (100 g) will be collected before application of aflasafe and at harvest to analyze microbial population structure. In addition, crop samples (30 maize ears/field) will be collected at harvest for chemical (aflatoxin) analysis on grains. Conscious efforts will be made to continuing to include youth and female farmers in this trial.

Sub-activity GH111B-1702: Registration of two aflasafe products with Ghana-Environmental Protection Agency for use in Ghana at scale - Leader: Alejandro Ortega-Beltran

Data from field efficacy trials from 2015 and 2016 will be used to prepare the registration dossier following the requirements of Ghana's EPA regarding registration of biopesticides. Dossiers prepared to register aflasafe products in Nigeria, Kenya, Senegal, and The Gambia will be used as a guide as well.

5. Data to be collected and uploaded	Responsibility/ Institute
5.1 Baseline data on farmers and coordinates of fields	Daniel Agbetiameh/ IITA
5.2 Data on chemical (aflatoxin) analysis	Daniel Agbetiameh/ IITA
5.3 Data on microbial analysis	Daniel Agbetiameh/ IITA

6. Milestones

Deliverables	Means of verification	Date
6.1 Microbiological and chemical database: proportion of isolates belonging to the genetic groups to which the atoxigenic strains of aflasafe products belong. Aflatoxin content of treated and non-treated crops.	Laboratory testing	Aug. 2017
6.2 Guideline manual indicating mode and frequency of application of aflasafe products in each region and cropping system.	Manual produced by IITA	Jul. 2018
6.3 Published journal paper "Efficacy of both aflasafe products in reducing aflatoxin accumulation" intended for 'Plant Disease' or 'PLOS ONE'	Acceptance by the Journal	Dec. 2017

6.4 Dossier for registration of aflasafe GH01 and aflasafe GH02	Approved registration	Dec. 2017

7. Sustainable intensification indicators	
7.1 Productivity	Crop yield at field and farm levels
7.2 Environmental	Biopesticide use at plot level
7.3 Economic	Profitability and input use efficiency and the plot and farm levels
7.4 Social	Gender equity at the farm and household levels
7.5 Human	Production of nutritious foods at the farm and household levels

8. How will scaling be achieved?	
Once registered, both products will be available to maize and groundnut farmers across Ghana. IITA is in the process of identifying key partners for production, commercialization, and use of both aflasafe products throughout Ghana at scale as part of the Aflasafe Technology Transfer and Commercialization Project, funded by USAID and the Bill & Melinda Gates Foundation. Scaling up the use of aflasafe will be done in collaboration with the government of Ghana, non-governmental organizations (NGOs), and private sector actors interested in improving maize and groundnut value chains as well as enhance nutritional status of farm households. Producers (farmers) will be linked with premium markets and processors seeking aflatoxin-safe maize and groundnut.	

9. How are the activities in this protocol linked to those of others?	
Linked to protocol GH111A-17 Aflatoxin-safe maize/groundnut from treated fields can be used in studies involving the poultry/livestock feeding trials as well as for studies on household nutrition for children under 5 years.	

10. Budget (USD)	
Budget Line	
Personnel	12,000
Services	7,000
Supplies	7,000
Capital	
Travel	4,000
Overhead	0
Total	30,000

2017 Africa RISING West Africa Activity Protocol – Outcome 1: GH121-17				
Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.				
a. Output: 1.2	Integrated management technologies and practices to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated with farmers and development partners in the intervention communities			
b. Activity: 1.2.1	Test and disseminate land, soil and integrated land-soil technologies and practices to improve and sustain productivity and ecosystems services at the farm and landscape/watershed levels			
c. Sub-activity: GH121-17	Roll out soil and water conservation measures in selected farming systems to demonstrate their role towards in-situ moisture capture and storage, erosion reduction and climate risk adaptation			
d. Research team				
Name	Institution	Role		
Fred Kizito	CIAT	PI: Land management strategies		
Wilson Agyare	KNUST	Co-PI: Soil-water dynamics		
Gundula Fischer	IITA	Gender mainstreaming		
Bekele Kotu	IITA	Economic studies		
Olufunke Cofie	IWMI	Co-PI: Water management		
Richard Appoh	IWMI	Water management		
e. Student(s)				
Name	Institute	Degree	Start	End
1.				
2.				
3.				
f. Location(s)	Upper East (Bonia and Nyangua) and Northern (Tibali) regions			
g. Start	May 2017			
h. End	February 2018			
1. Justification				
During Phase 1, land use changes within agricultural landscapes were evaluated. This revealed that there has been substantial transition of the farming systems and land use patterns, predominantly from shrubland and forested areas into crop land which has taken place alongside other drivers such as low and erratic rainfall and poor soil and land management practices. In order to provide viable interventions and recommendations, we proposed piloting of on-farm trials to address erosion prevalence and land degradation that will in turn increase crop productivity. Soil and land management strategies for improved crop production form an intrinsic component of farming systems. However, these do not act in isolation, there is a need for integrated technologies for crop management that are labor-friendly. The proposed work aims to refine soil and water conservation technologies identified in Phase 1 and disseminate appropriate soil and land management strategies that are labor-friendly but also intensify cereal-legume and livestock farming systems in northern Ghana in conjunction with the crop and crop-livestock activities. The envisaged activities include: 1) Demonstration and implementation of best-bet soil and land conservation interventions for improved crop and water productivity with specific reference to tied ridges, and contour farming practices accompanied with dual-purpose cover crops such as cowpea and soybeans within maize systems; 2) Roll out the economics of soil/land restoration and management strategies for improved crop productivity; 3) In				

conjunction with the on-farm agronomic trials, train farmers and support their networks on soil and land conservation interventions. Water availability, soil quality and land suitability are intricately linked and are the foundations for food production. However, all these resources are under increasing pressure in northern Ghana as food and living standard demands increase with the rising population pressure. Among others, some of the entry points to managing these pressures while increasing production and buffering against shocks include judicious and economically feasible soil and land management strategies that address the chronic problems associated with soil erosion and subsequent nutrient losses. The proposed work will conduct activities that reduce soil and nutrient losses from the farm systems through soil erosion reduction interventions that subsequently increase root zone soil moisture storage and nutrient availability. Periodic measurement and monitoring of on-farm fluxes will continue in order to provide metrics that help evaluate the performance of the implemented interventions and provide a matrix against which econometric assessments will be conducted. This will be coupled with training and building the capacity of farmers to make decisions with the consideration of the value of soil and land management actions towards in-situ moisture capture and storage, erosion reduction and climate risk adaptation. The activities are related to those under Activity RT4-Gh-3 in the 2016 research year work plans of Phase 1.
2. Objectives
2.1 Roll out and scale out integrated soil/land and water management practices to increase ecosystems services at the farm and landscape levels. The intervention practices will entail tied ridges, contour farming and contour ridges accompanied with dual-purpose cover crops such as cowpeas or soybeans within maize systems
2.2 Adapt and disseminate cost-effective, labor-saving, and gender-sensitivity of the soil and land management technologies identified in 2.1 above
2.3 Develop both human and institutional capacity of target farmers towards in-situ moisture capture and storage, erosion reduction and climate risk adaptation
3. Research questions
3.1 How can we best roll out and disseminate land and soil management practices to improve crop and livestock production and ecosystems services (including soil, water and nutrient cycling) at the farm and landscape/watershed levels?
3.2. What are the economics associated with soil and land management technologies and are these cost-effective, labor-saving, and gender-sensitive enough to allow for uptake and scaling out these best bet options?
3.3 How can we develop both human and institutional capacity of target farmers towards in-situ moisture capture and storage, erosion reduction and climate risk adaptation in order to promote better scaling?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
Sub-activity GH121-1701: Roll out and scale out soil and water conservation measures in selected farming systems to demonstrate their role towards in-situ moisture capture and storage, erosion reduction, nutrient movements and climate risk adaptation - Leader: Fred Kizito
This will entail establishing soil and water conservation measures specifically, tied ridges, contour ridges and native grass strips as well as a control in farmers' fields. The study will build on the water balance findings from Phase 1 to conduct a detailed analysis of the spatial and temporal trends of the data collected, an aspect that was not done in Phase 1. The assessment will include evaluation of soil conservation practices (both structural and vegetative) towards environmental integrity (allowing moisture infiltration, reducing erosion and nutrient losses). This will also involve use of GIS analysis and

spatial modeling to scale-up and out proven land and soil management interventions that have a high potential for increasing agricultural productivity.

Sub-activity GH121-1702: Conduct cost-benefit analysis coupled with farmers' perceptions on gender and labor demands associated with soil and water conservation measures in farming systems-
Leader: Fred Kizito

This activity builds on results derived from the soil and water conservation intervention strategies and has an economist and a gender expert on the team to provide guidance and insights on both economic and gender issues. Where situations are better-suited to segregation of genders for group work, we will address these as they arise and also on local advice and customs. In collaboration with other work packages, gender issues will be addressed through creation of gender awareness and gender equity in all the project stakeholder meetings. Barriers-to-participation are reduced by offering gender sensitive interventions and the use of appropriate styles and language in all capacity building activities. This work package will strive to ensure inclusion of women groups in the project activities in order to impart skills and knowledge to women. Specifically, we shall:

- Conduct economics of farm productivity that incorporate labor and level of effort for land and soil conservation measures;
- Quantify losses associated for the lack of action (would use on-farm counter-factual results); quantify (monetary and non-monetary) the benefits of action associated with interventions through a cost-benefit analysis and willingness to invest in soil and water conservation strategies

This will entail working closely with communities through practical in-field excursions with hands-on construction of soil and land management conservation structures while incorporating existing indigenous knowledge and other knowledge gathered from previous efforts and NGO exposure. (It is envisaged that this activity will come earlier in the process and will involve close collaboration with other work-packages for co-planning of events). It will also involve reinforcing knowledge during and after the cropping season.
This will also entail developing brochures and training manuals for educating and training farmers and extension officers in soil and water conservation measures.

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Roll out and scale out soil and water conservation measure: Measurements and metrics: • Soil losses will be monitored by a modified version of a calibrated runoff soil loss detectors that captures 75% of the plot runoff zone; • Climatic variables: Rainfall, air temperature, wind speed and relative humidity for crop evapotranspiration measurements; • Nutrient dynamics will be monitored using suction lysimeters which will be held at a tension of 70 cbars and installed at varying depths along the profiles of interest in order to ascertain fate and transport as well as verify what percentage is captured within the crop root zone; • Soil moisture will provide vital links to both soil and nutrient losses. Soil moisture will be monitored using a diviner probe (Sentenk Inc.) to depths of 1.6 m at 10 cm increments within the profile. Access tubes for moisture measurement with the diviner probe will be installed in the center position of the target plots; • Infiltration rates with a portable mini-disk infiltrometer	CIAT/KNUST

5.2 Conduct cost-benefit analysis coupled with farmers' perceptions on gender and labor demands: Metrics and data: Cost of inputs, amount of gender disaggregated labor demanded throughout the cropping season for soil and water interventions, yield levels, total income from a plot or farm level, off-season labor demands for reinforcing of soil and water conservation structures	CIAT/KNUST
5.3 Develop both human and institutional capacity of target farmers towards improved soil and water conservation measures: We shall assess the knowledge, attitude, skills and aspirations of farmers before and after the trainings and capacity building exercises. We shall use the KASA framework to make these assessments	CIAT/KNUST

6. Milestones

Deliverables	Means of verification	Date
6.1 Soil-crop-forage interactions rolled out and assessed at 3 project sites: Upper East (Bonia and Nyangua) and Northern Region (Tibali); areas with high potential identified and mapped	Research report and partner work plans (CIAT/KNUST)	Jul. 2017
6.2. Economics of farm productivity conducted with partial budgets and cost-benefit analysis that includes a gender lens	Research report and journal publication	Nov. 2017
6.3. Training manuals and brochures rolled out on soil and water conservation measures	Research report including list of participants and training agenda	Nov. 2017

7. Sustainable intensification indicators

7.1 Productivity	Crop yield and planting density at the plot levels.
7.2 Environmental	Erosion, soil health-quality, nutrient partial balances, runoff and water productivity at the plot levels
7.3 Economic	Profitability and Input Use Efficiency at plot and farm level
7.4 Social	Gender equity and collective action in labor and other resource uses
7.5 Human	Capacity to experiment

8. How will scaling be achieved?

Strategic partnerships with both public and private sector entities for public sector: we shall liaise with MoFA, theprivate sector, SNV and local universities. We envisaged that the targeted partners will be contacted and will be on board in August/September 2017. We shall involve the use of GIS analysis and spatial modeling to scale-up and out proven land and soil management interventions that have a high potential for increasing agricultural productivity while including crop suitability potential. This scaling mechanism will be developed and rolled out for the target sites by December 2017. The use of participatory video methods and maps will be used as information sharing methods in the target sites with partners and will complement the scaling-up and out through farmer to farmer exchanges on soil and land management interventions that increase on-farm productivity. We link up with on-going initiatives and partnerships such as Northern Agricultural Sector Working Group (NASWG) and NRGDP as scaling pathways for our research. This will include sharing with them brochures developed for farmer training as well as co-sharing in-field experiences at working group discussions including MoFA as well.

9. How are the activities in this protocol linked to those of others?
Linked to protocols GH111A-17 and GH122-17. This is an integrative activity in that CIAT, IITA, IWMI and KNUST will collaborate on soil and water conservation incorporation within farming systems. The work also closely links with IITA on cereal-legume cropping systems and will mimic the soil and water conservation approaches that incorporate grass strips in farming systems that have been successfully implemented in East Africa and will bring cross-regional insights. Insights from our work will be shared with IWMI for cross-learning opportunities between soil/land management strategies and water management interventions within the target farming systems.

10. Budget (USD)		
Budget Line	CIAT	KNUST
Personnel	25,300	4,000
Services	2,700	1,150
Supplies	3,600	1,200
Capital	900	700
Travel	3,600	1,500
Overhead	3,900	1,450
Total	40,000	10,000[1]
[1]Funds allocated by CIAT to KNUST		

2017 Africa RISING West Africa Activity Protocol – Outcome 1: GH122-17				
Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.				
a. Output: 1.2	Integrated management technologies and practices to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated with farmers and development partners in the intervention communities			
b. Activity: 1.2.2	Test and promote water management technologies and practices to increase water productivity in the small-scale crop-livestock farming systems under rain fed and irrigated conditions			
c. Sub-activity: GH122-17	Research after agricultural water management under rain fed and irrigation conditions to improve water productivity in integrated crop-livestock systems of northern Ghana			
d. Research team				
Name	Institution	Role		
Zenebe Adimassu	IWMI	Agricultural water management		
Marloes Mul	IWMI	Hydrology and water resources		
Richard Appoh	IWMI	Establishment of trails and data collection		
Jean-Baptiste Tignegre	WorldVeg	Vegetable breeding		
Fred Kizito	CIAT	Land and soil management		
e. Student(s)				
Name	Institute	Degree	Start	End
f. Location(s)	Upper East Region			
g. Start	Apr. 2017			
h. End	Mar. 2018			

1. Justification:	
Agriculture contributes about 25 % to Ghana's GDP while employing over 56 % of the labor force serving as the major source of livelihood for many rural communities in Ghana. In northern part of the country, rain-fed agriculture is predominant, with a uni-modal rainy season from May to September and intra-seasonal droughts. Water is therefore a key limiting factor for production in spite of the average annual rainfall amounts exceeding 1,000 mm/yr. Results from the Africa RISING (AR) Phase 1 research in northern Ghana show that there is a 60-80% chance of having more than seven consecutive days of dryness and 30-40% chance of more than 10 days dryness in the rainy season (Adimassu et al, forthcoming). Along period of dryness at sensitive times of plant development (germination, flowering, seeding) during the rainy season can be disastrous for smallholder farmers (Barron et al, 2003[3]; Mul et al., 2016[4]), adding to their vulnerability to climate variability. While shorter dry spells of 7-10 days can be overcome by infield water harvesting and by increasing water holding capacity of the soils, longer dry spells (14-21 days) require supplementary irrigation. Our results showed that northern Ghana record up to 25% reduction in maize yield due to long dry spells (Adimassu et al., forthcoming). Available evidence also shows that current maize yield in northern Ghana could increase to 4-6 tha^{-1} through reduced crop water deficit during rainy season, which is around 50 to 70% of potential achievable yields (see e.g. Global Yield Gap and Water Productivity Atlas[5]). Effective water management reduces risk in crop and livestock systems, building resilience towards shocks and change, and enhancing value of other farm inputs such as improved seeds, labor fertilizer/ nutrients and e.g., integrated pest and weed management in crop–livestock production systems. Beyond the uni-modal rainy season, long period of dry season in northern Ghana offers opportunity for farmers to intensify and diversify their production systems. Currently, only a small proportion of the cropland in northern Ghana is under more than one crop cycle per year whereas surface and groundwater resources are abundant on annual basis to realize double or triple cropping. For example, in the Anyari transboundary watershed which has an area of 253 km^2 within Ghana and which has some of the Africa RISING vegetable hubs, our research (Ofosu-Antwi et al., 2017[6]) shows that harvesting just 10% of the surface runoff by using dams, dugouts and underground tanks can support an irrigable area of 1,750 ha which could be used for dry season agriculture. In addition to surface water, the groundwater resources can irrigate up to 4,500 ha of land sustainably without any water stress. Upscaling irrigation in the Anyari catchment to 6,250 ha would lead to only 0.01% reduction in stream flow to Akosombo dam downstream of the Volta. When the untapped resources are explored, together with other considerations such as access to inputs, credit, market, and good agronomic practices, dry season production system that responds to local and regional price fluctuations in major commodity crops could provide additional source of income for farming households (Katik et al., 2017[7]).	

[3] Barron J., Rockstrom J., Gichuki F., Hatibu N., (2003). Dry spell analysis and maize yields for 2 semi-arid locations in East-Africa. *Agricultural and Forest Meteorology, 117*(1), pp.23-37.

[4] Mul, M.L. Kadyampakeni, D., Salifa, F., Sanon, A., Haruna, S., (2016). Agricultural water management practices as climate smart agricultural practices in West Africa. Draft report CCAFS Water Storage in West Africa

[5] Global Yield Gap and Water Productivity Atlas. Available URL: www.yieldgap.org (accessed on: November, 30, 2016).

[6] Ofosu Antwi Eric, Frank Annor, Marloes Mul (2017). Quantification of surface and groundwater resources in the Anyari watershed of the Upper East Region in Ghana. Technical report, 33 pg.

[7] Katic, P et al., (2017). Evidence for upscaling of dry season irrigation technologies: Market opportunities. Technical report. 45pp.

Although water management solutions offer greater security to agricultural production (ICSU, ISSC, 2015[8]) and expand the options for sustaining livelihoods as well as ensuring food security and nutrition (Domenech, 2015[9]), the efficiency of water in agricultural production is low at farm level. Generally, only the crop effectively uses 40 to 60% of applied water, the rest is usually lost through various processes including evaporation, runoff, and percolation into the groundwater. It is therefore critical to develop agricultural water management strategies with smallholder farmers to attain better productivity and efficiency of water for sustainable intensification, and contribution to Sustainable Development Goals (SDG), especially SDG 6.3 for water productivity improvements

A first step is to ensure intra seasonal dry spells is managed during rain fed seasons. Furthermore, it is important to ensure that the right amount of water is applied at the right time to avoid needless waste of water and energy. Unfortunately, many small-scale farmers do not have the knowledge and tools for determining the right amount of water and time to apply. Irrigation scheduling ensures that water is optimally available to the plant if applied according to crop requirements. However, irrigation also incurs a cost for labor and energy so the optimal water allocation from the biophysical and crop production perspective should coincide with the economic optimal water productivity. Simple decision support tools can be used to guide farmers on when to irrigate and in what amount. For example, WRI and partners recently introduced an ICT-based tool for irrigation advisory service to the irrigation sector in Ghana. Preliminary results show that it is possible to incorporate near-real time monitoring of climate and soil conditions with spreadsheet-based water balance models to advice farmers regarding when to irrigate and how much water to apply. Such tools can be used by irrigation officers, agronomist, agricultural extension agents and some farmers, with minimal training. Although it has been applied to some elected formal irrigation schemes in Ghana, its adaptability to smallholder single farm units is yet to be proven. In addition, IWMI introduced the wetting front detectors (WFD) during the phase 1 of AR in Ethiopia and in Ghana. While in Ethiopia, the use of WFD in guiding supplementary irrigation of oats and vetch resulted in 64% yield increase, the investigation in Ghana has so far been constrained by multiple factors.

Research is needed to understand to what extent the access to scheduling tools such as the WFD and ICT-based tools would improve crop and water productivity. Furthermore, the interaction of water deficit and soil amendments to improve vegetable (tomato) production has received little attention. Water deficit and soil nutrient management have been studied in isolation and the synergy has not been explored. It is hypothesized that the interaction of soil water deficit and soil nutrient management will provide new technology to improve tomato yields in the Upper East Region. This will provide new options to for tomato production in soil nutrient stress and water deficit environment in the Upper East Region. We therefore propose our research to focus on improving agricultural water management in sustainable intensification of northern Ghana smallholder rain fed and dry season crop-livestock production systems.

The proposed activities are related to activities RT4-Gh-1 and RT4-Gh-2 in the 2016 research year work plans of Phase 1.

2. Objectives:
2.1 Assess the incidence of dry spell occurrence and its impacts on AR commodities, in crop-livestock systems and provide recommendations for mitigation measures
2.2 Assess the effectiveness of a computerized water balance irrigation scheduling tool for enhancing irrigation efficiency and crop productivity in dry season vegetable production systems

[8] ICSU (2015). Review of the Sustainable Development Goals:The Science Perspective. Paris: International Council for Science (ICSU).

[9] Domenech, L. (2015). Improving irrigation access to combat food security and undernutrition: a review. Global food Security 6: 24-33

2.3 Assess the effectiveness of the Wetting Front Detector (WFD) irrigation scheduling tool for dry season vegetable production system and the implication on crop water productivity
2.4.1 To assess soil water and organic amendments effects on tomato crop production in the Upper East Region of Ghana
2.4.2 To assess soil N mineralization under soil water and organic amendments management in tomato production
2.4.3 To study soil N leaching under soil water and organic amendments management in tomato production
3. Research questions
3.1 What is the extent and impacts of dry spell occurrence in the production of major AR commodities, in crop-livestock rain fed production systems? What are the appropriate measures to mitigate DS and improve productivity?
3.3 How effective and applicable is the WFD for scheduling irrigation of different dry season vegetable production?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
Sub-activity GH122-1701: Analysis of dry spell incidence in cereal-legume cropping systems - Leader: Zenebe Adimassu
A dry day is taken to be a day with less than 0.85 mm of rainfall while a dry spell is a period with consecutive dry days once the cropping season begins. Dry spells are categorized into different length and occurrences in different crop stages. Dry spell analyses in Africa RISING phase 1 had focused on 90-day maize crop for nine rain gauge sites in northern Ghana and for six crops using the Navrongo rainfall data (Adimassu et al., 2017[10]). This study will expand the analysis to integrate yield response towards dry spells. Historical rainfall data from meteorological stations in northern Ghana with daily rainfall data covering at least twenty years will be analyzed for dry spells. Long-term dry spell analysis would be carried out using INSTAT+ v3.37. The probabilities of dry spell lengths exceeding 7, 10, 14 and 21 days will be calculated. The probabilities will be calculated to cover each growing stage for major crops grown in the Africa RISING project. CROPWAT 8.0 model (FAO, 2005[11]) will be used to estimate yield responses using historical data, and compared to the dry spell categories.
Sub-activity GH122-1702: Determining appropriate water scheduling methods for enhanced crop and water productivity in dry season vegetable production – - Leader: Richard Appoh
Irrigation scheduling technologies will be tested in the vegetable hubs located in Nayngua and Tekuru in collaboration with World Vegetable Centre to assess the impact on crop water productivity as well as the socio-economics requirements for up scaling. Water scheduling: Wetting Front Detector, a sensor-based simple tool will be tested on vegetables to be selected by farmers. This will assist them to schedule the irrigation of vegetables. The tool indicates when the root-zone is dry and when it becomes saturated during irrigation. The water productivity using the sensors will be compared against i) a fixed irrigation schedule and ii) the farmers' normal practice. Recommended fertilizer and pest management practices will be implemented for all treatments. The experiment will provide an opportunity for farmers to compare the tested irrigation

[10] Adimassu, Z., M. Mul., A. Owusu, J. Barron, Kadyampakeni, D. and Cofie, O. (2017). Smallholder irrigation productivity for sustainable intensification: water balances for high value crops in northern Ghana. Technical Report 38pp.

[11] FAO, 2005.CROPWAT 8.0. (http://www.fao.org/nr/water/infores_databases_cropwat).

scheduling methods (Wetting Front Detector, crop water requirements and farmer practice) with respect to income, water, labor and time savings.	
5. Data to be collected and uploaded	Responsibility/Institute
5.1. For dry spell analysis: climate data including rainfall data, temperature, PET (20-30 years)	IWMI
5. 2 For dry season vegetable production: • Yield – [marketable yield (kg/plot), unmarketable yield (kg/plot), total yield (Kg/ha)] at each harvest. • Soil moisture • Irrigation quantity applied and frequency • Fertilizer (type, quantity, timing, cost) • Weed control (type, quantity, timing, cost) • pest control (type, quantity, timing, cost) • What, when and how much labour involved • Cost of other inputs • Total income from the plot (Cedis/farm)	IWMI

6. Milestones		
Deliverables	Means of verification	Date
6.1. Dry spell incidence mapped out for AR regions in Ghana	A journal paper submitted to Agric. Water Management	Dec. 2017
6.3. Recommendations on irrigation scheduling methods for enhanced crop water productivity in the dry season	A project report to be published on CGspace on effects of irrigation scheduling on crop and water productivity	Mar. 2020

7. Sustainable intensification indicators	
7.1 Productivity	Crop production at plot and field levels.
7.2 Environmental	Water availability: Field/plot level/metrics
7.3 Economic	Profitability and input use efficiency at the field level
7.4 Social	Gender equity; collective action in the use of available water resources
7.5 Human	Food Security: Field/plot level/metrics Food production (Participatory assessment, survey)

8. How will scaling be achieved?	
Scaling will be achieved by organizing stakeholder meetings with farmers and extension officers on the results of the trials, the preferred water scheduling and application methods during the dry season as well as the supplementary irrigation options for rainy season production. The project teams will share research results and engage with potential scaling partners in the Northern Agricultural Sector working Group (NASWG) which is a dialogue platform for engaging the government and development partners in the realization of the agriculture policy in the north. Co-generation of knowledge through on-farm demonstration will be used to scale out innovative technologies. Fact sheets, workshops, radio discussions, policy briefs, as well as scientific papers publication will be used to communicate to the wider populace.	
9. How are the activities in this protocol linked to those of others?	

Linked to GH111A-17 and GH122-17.

10. Budget (USD)	
Budget Line	IWMI
Personnel	35,300
Consultant	1,000
Services	12,910
Supplies	952
Capital	
Travel	9,000
Overhead	10,838
Total	70,000

2017 Africa RISING West Africa Activity Protocol – Outcome 2: GH211-17				
Outcome 2: More farmers and farm families in the intervention communities are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling and value addition.				
a. Output: 2.1	Improved technologies, practices and habits to increase production and consumption of diverse and more nutritious food by farm families, especially by women and children, are developed			
b. Activity: 2.1.1, 2.1.2, 2.1.3	Develop a nutrition strategy to harmonize the nutrition activities with the national nutrition approaches and link them to the crop and livestock activities; train farm families to produce and consume diverse and nutritious food; and use nutrition activities for greater involvement of younger women and youth			
c. Sub-activity: GH211-17	Evaluation of nutrition-sensitive-agriculture options in West Africa			
d. Research team				
Name	Institution	Role		
Augustine Ayantunde	ILRI	Lead livestock component		
Mahama Saaka	UDS	Lead nutrition component		
Jean Baptiste Tignegre	WorldVeg	Vegetable production		
Adda Waseh	UDS	Ruminant nutrition		
Emmanuel Adu	ARI	Animal production		
WIAD Officer	MoFA	Agricultural extension		
Herbert Dei	UDS	Poultry nutritionist		
District Nutriton Officers	GHS	Nutrition education		
e. Student(s)				
Name	Institute	Degree	Start	End
f. Location(s)	Selected intervention communities in the three regions			
g. Start	2017			
h. End	2021			

1. Justification	
The USAID commissioned external evaluation team in Phase 1 stated that: *'... generally, nutrition programming is sporadic and poorly integrated with other programming efforts, therefore requiring a more deliberate programming in relation to agronomy and livestock' and 'Africa RISING in West Africa appears to work primarily with an older demographic, with limited visibility of younger women or men in trials'*. They recommended that: 1) the nutrition activities should be harmonized with national nutrition approaches, and provide opportunities for capacity building and active participation of government nutrition workers; 2) the nutrition focused activities should be used as an entry point for greater levels of involvement of younger women, since the program's current work involves only older women; 3) younger women and youth should be more proactively targeted to participate in the program; and 4) more deliberate emphasis should be placed on supporting women's specific areas of interest (e.g., small ruminants, poultry and dry season vegetable production). This activity protocol addresses the above recommendations of the external evaluation team by linking the nutrition with the livestock and vegetable production activities focusing on women and children under 5 years as well as the youth. Agricultural practices and interventions can be better adapted and redesigned to maximize health and nutrition benefits and to reduce malnutrition and diseases. In northern Ghana, where small-scale livestock rearing is practiced in nearly 80% of the households, the prevalence of under-nutrition and micronutrient deficiencies remains unacceptably high. In rural areas of northern Ghana, inadequate intake of micronutrients is widespread primarily because staple diets are predominantly cereal based, and intake of animal source foods are low. More efforts to raise small animals and promote consumption of their products will enhance dietary quality and ensure optimal growth, health and cognitive development in young children. Promotion of dietary diversity using locally available nutritious foods is an effective approach in low-income areas to improve the quality of young children's diets and, hence, their growth and development. The proportion of growth stunted children is highest (33.1 %) in northern Ghana compared to other regions in the country. Similarly, 82 % of children aged 6-59 months have some level of anemia (Hb<11g/dL). Dietary quality and diversity remain unsatisfactory in many households (GSS et al., 2015[12]). The importance of consumption of animal source food (ASF) for cognitive development of children is well documented. For example, nutritional study in Gourma in Northern part of Mali showed that the children of mobile pastoralists were better nourished based on weight-height, weight-age and height-age measures than children of sedentary farmers and that the children of the sedentarized pastoralists seem to be worst off (Pedersen and Benjaminsen, 2008[13]). The children under these studies were 6 to 60 months. The explanation for this trend was largely attributed to the consumption of milk. This underscores the important role that livestock systems play in human nutrition as the households that keep livestock are more likely than their non-holding counterparts to consume ASF because of their proximity to the nutrient-rich foods. Increased consumption of ASF by the rural households may prevent or reduce stunting in children and will improve the health of the households particularly children and vulnerable women. Thus, there is need for increased consumption of animal source food by the households in crop-livestock systems in Africa RISING intervention communities where staple food is largely based on cereals. One pathway to improve the consumption of ASF is through improvement in livestock production, for example improved milk and meat by ruminants (cattle, sheep and goats) and non-ruminants (poultry	

[12] Ghana Statistical Service (GSS), Ghana Health Service (GHS), ICF International, 2015. Ghana Demographic and Health Survey 2014. GSS, GHS, and ICF International, Rockville, Maryland, USA.
[13] Pedersen J. and Benjaminsen, T.A., 2008. One leg or two? Food security and pastoralism in the Northern Sahel. *Human Ecology, 36*(1), pp.43-57.

and pigs), and egg production by poultry. As the women are key in the household nutrition, livestock-related nutrition interventions should be gender-sensitive. Bringing together agriculture, nutrition and health will help to address immediate and underlying causes of malnutrition and nutrition insecurity in the Africa RISING intervention communities. In addition to interventions to improve household nutrition, there will be focus on building capacity in best nutrition practices and nutrition behavior change communication targeted at women to foster the creation of an environment where women feel comfortable to change and adopt best nutrition practices.

It is widely known that nutritional status during foetal life influences the postnatal growth and body composition of children but little information is available on how consumption of animal source foods (ASF) affects foetal and postnatal growth as a continuum. Besides, no randomized controlled intervention trials have investigated the effects of prenatal food-based interventions on the outcomes of the offspring, including postnatal growth within the context of women empowerment in agriculture production of ASF. Therefore, this study serves as an opportunity to collect follow-up data of the women and their offspring at birth and through the first three years postpartum. The intervention trial proposes to answer whether production of ASF reduces micronutrient deficiencies and promotes foetal and postnatal growth. In this study, the effects of the improved intensification options with and without nutrition education on maternal and child nutritional status, child care practices, income, and workload will be investigated.

In addition to ASF, consumption of other nutritious food and vegetables is necessary and will be addressed in this study. For poor households, vegetables and fruits are often the only source of micronutrients in the family diet. Homestead production of fruits and vegetables such as okra, Amaranth and vegetable cowpea provides the household with direct access to important nutrients that may not be readily available or within their economic reach. This underscores the importance of the home garden for household nutrition. Therefore, home gardening will be a good means to improve household food security and diet. The household garden is a small-scale production system supplying plant and animal consumption and utilitarian items either not obtainable, affordable, or readily available through retail markets, field cultivation, hunting, gathering, fishing, and wage earning.
The nutrition activities proposed in this study are designed to target women and children. Women play a critical role in household nutrition as the primary producers of micronutrient rich vegetables, and they are responsible for the purchase of food at the local markets and preparation of food in the home. In addition, they take care of the children under 5 years old. Consequently, the integrated package for improving household nutrition through this study will be given to women in the selected Africa RISING intervention communities.

This protocol covers activities 2.1.1, 2.1.2 and 2.1.3 in the Africa RISING West Africa Phase 2 log frame (Table 1); and activities, RT2-Gh-3, RT3-Gh-1, RT3-Gh-2, RT3-Gh-3 and RT5-Gh-1 in the 2017 research year work plans.

2. Objectives

2.1 Develop a nutrition strategy for the project

2.2: To: (i) characterize nutrition practices of the households in the study areas and quantify gender-differentiated roles in household nutrition practices; (ii) assess the effect of livestock productivity enhancing interventions and vegetable production in home-gardens with or without nutrition education on household nutrition particularly children under 2 years and women of reproductive age. The underlying hypothesis is that productivity enhancing intensification options will lead to improvement of household food security and nutrition thereby enhancing gender equity

2.3: To determine the operational feasibility and effectiveness of women's empowerment in agriculture to increase production diversity and improve maternal and child nutritional outcomes without compromising child care practices

3. Research questions
3.1: Do improved intensification options with and without nutrition education impact on maternal and child nutritional status and child care practices?
3.2 Will the nutritional status of children and pregnant women be improved through combined Women's Empowerment in Agriculture and Social Behavior Change Communication (SBCC) that promote production and consumption of animal-source foods (ASF) such as poultry and small ruminants?
3.3 Does social mobilization for nutrition and health create a platform for young women to adopt and practices best nutrition practices?
3.3: Can women's empowerment in agriculture lead to increased production diversity and dietary diversity without compromising child care practices?
3.4 Can homestead gardening increase household food security and nutrition in rural household of northern Ghana?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1Linking nutrition and crop-livestock research and development activities- Leader(s): Asamoah Larbi and Mahama Saaka
In response to the recommendations of the USAID commissioned evaluation team, a consultant will be hired to develop a nutrition strategy for the regional project. The strategy will indicate how the nutrition activities will be linked to the livestock and crop research activities. This activity was planned for 2016. It could not be implemented due to delays in hiring a consultant.
4.2 Evaluation of nutrition sensitive agriculture options - Leaders: Augustine Ayantunde and Mahama Saaka
Community based intervention using a quasi-experimental design with a baseline survey and an end of project survey will be used. The study will be conducted in at least 4 Africa RISING intervention communities and will involve focus group discussions and individual surveys to collect gender-disaggregated data on roles of gender in household nutrition and to characterize household nutrition practices of the selected households. A cluster-randomized controlled intervention trial will be used with an intervention group in selected communities in the Northern region and a non-intervention group in control communities in Upper East region. A survey of marketed foods in the study areas will be conducted as available food types in the markets and price may influence household nutrition and diet diversity. To establish dietary diversity of selected households, surveys will be executed that quantify the Minimum Diet Diversity for Women (MDD-W) score, and infant and young children feeding practices (children dietary diversity score, minimum acceptable diet). In addition, anthropometric measurements (weight for age/height, height for age) of children in selected households in the study areas will be carried out. Project interventions will include introduction of livestock (e.g., dairy goat, domestic chicken or guinea fowl) breeds to the intervention communities after assessment of performance on-station. The dairy goats and domestic chicken or guinea fowl will be given to selected women in 2 project communities in Northern region to manage after training in improved husbandry practices while 2 other communities in Upper East where there is no intervention will serve as control. The women are targeted to ensure that the milk and egg produced goes into household nutrition, particularly for consumption by children under 2 years. In addition to livestock intervention, a vegetable garden will be established by the women involved in the treatment communities and they will be trained in improved cooking practices for preparing the vegetables grown for household consumption. The manure from goats will be collected and applied to vegetable garden.

The trained women are expected to have gained knowledge about gardening, and animal husbandry thereby getting a better understanding of how agricultural interventions can improve family nutrition and health. This perceived benefit of the interventions is expected to motivate the women to actively participate in the study. Behavior change communication (BCC) group sessions on improved nutrition and cooking demonstrations (aimed at optimizing the nutritional quality) will be held targeting particularly women of reproductive age. Community mobilization activities will be organized in targeted villages with selected groups including local stakeholders, and groups of men and grandmothers. A quasi experimental design will be used to evaluate the impact of this intervention on target communities by using the data collected during the baseline and the end of project survey. Gender disaggregated data will be collected during monitoring activities and surveys.

Information on demographic, socio-economic and home garden information will be collected during household interviews using a structured questionnaire. An inventory of the cultivated plant species will be compiled and the number of individual plants of each species documented. Household food intake will be assessed by a qualitative recall of foods consumed by the household during the 24-hour preceding the survey from the household member who prepared the previous day's meals. The main independent variable will be production and consumption of nutrient-dense foods. Household food security will be assessed by using food consumption score (FCS) developed by the World Food Programme (WFP).

A quasi-experimental design will be used with an intervention group in selected communities in one region and a non-intervention group in selected communities in an adjacent region. In the first year of the study, an appropriate sample size of pregnant women in the first trimester will be enrolled and they will be selected from 30 clusters. The clusters will be selected using the probability proportionate to size (PPS) method. Pregnant women in the first trimester will constitute the target group for this study because of their vulnerability to malnutrition and intergenerational transfer of malnutrition. The participants will be randomly assigned to one of the following treatment arms:
(i) Usual diet + Social Behavior Change Communication (SBCC).
(ii) Production of ASF (guinea-fowls, sheep, goats, poultry etc.) + vegetables
(iii) SBCC + ASF + vegetables

The main activities will a) include provision of facilities to women's groups for rearing livestock such as goats and sheep or guinea-fowls, b) provision of improved breeds of animals and guinea-fowls, c) Social behavior Change Communication in project communities, d) training, monitoring of activities, e) conduct a baseline and follow-up studies.

5. Data to be collected and uploaded	Responsibility/Institute
5.1: Infant and young child feeding (IYCF) practices to measure minimum dietary diversity (MDD), minimum meal frequency (MMF), and minimum acceptable diet (MAD); Nutritional status of children measured in terms of height-for-age Z-score (HAZ), weight-for-height Z-score (WHZ) and weight-for-age Z-score (WAZ); Body mass index (BMI) and mid upper arm circumference for women; food access information as measured by household food insecurity access scale (HFIAS) and market prices of food, changes in nutritional knowledge of women	UDS/ILRI/ARI
5.2 Survey data upload in CKAN	UDS/ILRI
5.3 Monitoring data upload in CKAN	UDS/ILRI
5.4 Animal performance data	ILRI/ARI

5.5: Access to nutritious foods, Dietary diversity, Food consumption score, Nutritional status (underweight, stunting, wasting), Uptake of essential nutrients, Food availability, Food accessibility, Food utilization, Food security composite index, Months of food insecurity and household income and expenditure levels	UDS/WIAD/District Assemblies
5.6 Data on maternal dietary intake, maternal micronutrient status assessment (e.g. iron, zinc), birth size (i.e. birth weight, length), growth rate during the first three years of life, anthropometric indicators during pregnancy (e.g. gestational weight gain). On enrolment, mid upper arm circumference, weights and heights of the pregnant women will be measured. Additionally, age, parity, level of education, employment, and other socioeconomic information will be collected as independent variables	Nutrition and Animal Science Departments of UDS/GHS
5.7 Data on Women's Empowerment in Agriculture Index [WEAI] and its component indicators will be used to assess the extent of women's empowerment in agriculture. WEAI is an aggregate indicator composed of two sub-indexes: (1) the five domains of women's empowerment [5DE] and (2) the Gender Parity Index (GPI)	Nutrition and Animal Science Departments of UDS/MOFA
5.8 Data to be collected on vegetables include plant height at 50% flowering, number of leaves/plant, number of fruits/plot and fruit weight (1st, 2nd and 3rd harvest), quantity consumed. Data will also be collected on farmers' sex, age, wealth, farm land GPS position, annual rainfall	WorldVeg/IITA

6. Milestones

Deliverables	Means of verification	Date
6.1 Baseline survey data (quantitative and qualitative)	Report submitted to Africa RISING and data upload in CKAN	Dec. 2017
6.2 Progress report on the on-station assessment of the productive performance of improved dairy goat and domestic chicken/guinea fowl, and development of feed package for the dairy goat	Reports submitted to Africa RISING	Jan. 2018
6.3 Progress report on the establishment of home garden (nutrition garden) and monitoring	Reports	Jan. 2018
6.4 Training in best nutrition practices and improved animal husbandry	Reports	Various dates
6.5 End of project survey data (quantitative and qualitative)	Report submitted and data upload in CKAN	May 2020
6.6 Articles published in the following areas: i. Effect of consumption of animal source foods (ASF) on foetal and postnatal growth (August 2018) ii. An evaluation of improved intensification options with and without nutrition education on maternal and child nutritional status, child care practices, income, and workload (August 2019) iii. An assessment of the operational feasibility and effectiveness of women's	At least 2 journal articles on nutrition-sensitive agricultural interventions available online	2018, 2019

empowerment in agriculture to increase production diversity and improved maternal and child nutritional outcomes without compromising child care practices (December 2019) iv. The effect of an integrated livestock-vegetable-nutrition intervention on dietary intake and nutritional status of children under 3-years and pregnant women (December 2018)		
Articles pending from Phase 1: v. Evaluation on the effect of nutrition education package to improve household nutrition in Northern Ghana (May, 2017) vi. The combined effects of the provision of feed and healthcare on nutrient utilization and growth performance of sheep during the early or late dry season vii. Emerging feed markets for ruminant production in urban and peri-urban areas of Northern Ghana	Online publication Tropical Animal Health and Production Tropical Animal Health and Production	Dec. 2017 Dec. 2017 Dec. 2017

7. Sustainable intensification indicators	
7.1 Productivity	Crop and animal production at the plot, farm and household levels
7.2 Environmental	Soil health at the farm and household levels
7.3 Economic	Profitability and input use efficiency at the plot farm and household levels
7.4 Social	Gender equity
7.5 Human	Production of nutritious food at the plot and farm level Consumption of nutritious food at household level Nutrition awareness at the household levels

8. How will scaling be achieved?	
Scaling up nutrition and agricultural interventions entails identifying those programs and practices of proven efficacy and applying management, communications, and monitoring principles and tools to expand the number of beneficiaries until everyone who requires the product or service is reached. During the process of scaling-up, given resource constraints and as a good management practice, it is often necessary to prioritize groups that have a more urgent need (in this case the most undernourished children). The main platforms through which nutrition interventions can be scaled up are health systems (where government is usually in the lead and the private sector also has a role) and food systems (where the private sector is most active, but government has an important role to play). In this regard, we shall work with Ghana Health Services in disseminating key research outputs on the nutritional benefits, particularly on pregnant women and children (6-36 months) of the livestock and vegetable production interventions by this study. As research outputs are expected from Year 2 of the study, we envisage that the dissemination activities will start in Year 2. In addition, to Ghana Health Services, we shall also engage NGOs working on nutrition education in scaling the outputs from this study.	

Findings from the study will provide insights into how prenatal food-based interventions can positively influence postnatal growth through women empowerment in agriculture production of ASF. It is therefore expected that any positive finding will be scaled-up through key stakeholders such as the Ministries of Health and Agriculture.
9. How are the activities in this protocol linked to those of others?
Linked to protocol GH111A-17 and GH111B-17.

10. Budget (USD)				
Budget Line	ILRI	UDS	WorldVeg	
Personnel	39,000	6,600	3,000	
Services	15,000	5,000	1,500	
Supplies	25,000	1,900	1,500	
Capital	0		1,000	
Travel	10,744	3,000	1,750	
Overhead (17.5%)	15,256	3,500	1,750	
Total	105,000	20,000	10,000	

2017 Africa RISING West Africa Activity Protocol – Outcome 2: GH221-17				
Outcome 2: More farmers and farm families are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling and value addition.				
a. Output: 2.2	Post-harvest technologies and practices to provide options for the food, and feed sectors are tested and disseminated to farmers, through researchers, extension staff, and development partners			
b. Activity: 2.2.1 and 2.2.2	Introduce, evaluate, adapt and disseminate existing post-harvest technologies and practices; and build capacity of farm families to reduce post-harvest losses			
c. Sub-activity: GH221-17	Reducing post-harvest losses in stored grains of cereals and legumes			
d. Research team				
Name	*Institution*	*Role*		
Adebayo Abass	IITA	Post-harvest studies		
Bekele Kotu	IITA	Economic studies)		
Kofi Danso	IITA	Post-harvest management		
Abdul Rahman Nurudeen	IITA	Agronomy		
Gundula Fischer	IITA	Gender studies		
Kipo Jimah	IITA	Gender studies		
Shaibu Mellon	IITA	Economics studies		
Issah Sugri	SARI	Post-harvest management		
Mutari Abdullai	SARI	Post-harvest management		
e. Student(s)				
Name	Institute	Degree	Start	End

f. Location(s)	13 communities (5 NR, 5 UWR, 3 UER)
g. Start	April 2017
h. End	September 2019

1. Justification

The post-harvest system consists of the delivery of a crop from the time and place of harvest to the time and place of consumption, with minimum loss, maximum efficiency and maximum return to all involved (Spurgeon, D., 1976[14]). It encompasses a sequence of activities and operations that can be divided into technical (harvesting, shelling, field drying, threshing, cleaning, additional drying, storage, processing); and economic (transporting, marketing, quality control, nutrition, extension, information and communication, administration and management) activities.
Post-harvest losses occur between harvest and the moment of human consumption. They include on-farm losses, such as when grain is threshed, winnowed and dried, as well as losses along the chain during transportation, storage and processing. Important in many developing countries, particularly in Africa, are on-farm losses during storage, when the grain is being stored for auto-consumption or while the farmer awaits a selling opportunity or a rise in prices.

Limited post-harvest research was undertaken by the Africa RISING West Africa project in Mali and Ghana in Phase 1. It focused on the comparison of jute sack, PICS bag and GS4 sacks either with or without protectants (Actellic Super EC and phostoxin); and the effect of hermitic plastic tanks with or without grain protectants. There is need to compare farmers' silos with modified farmers' silo (improved) and GS4 silos bags (e.g., 1 ton capacity). New methods for drying must also be compared and demonstrated, and study both biophysical and socio-economic factors affecting adoption of improved postharvest practices by farmers.

Farmers are at great risk of losing significant amounts of their harvest and consequently their income, due to their inability to properly store their grain - cereals (maize) and legume (cowpea and groundnut). Most farmers have limited knowledge on stored-grain management. Current farmer threshing and shelling practices lead to breakage. Poor sorting and drying lead to pest and disease infestation, high percentages of foreign matter, and high moisture content that can cause mycotoxin contamination. Storage is often done in homes using traditional silos and jute bags, without adequate protection from pests or routine fumigation leading to low grain quality. There are a number of innovative shelling, drying and storage technologies available, but these are yet to reach and/or be adapted/adopted by farmers, traders and government agencies involved in food storage due to technical and socio-economic reasons. There is need to train farmers, extension agents and researchers on stored-grain management, especially with respect to, maize, cowpea and groundnut. Building individual and institutional capacities in post-harvest research and development will be embedded in all activities under this protocol.

Adding value to crop and livestock products to improve quality and market value is limited at the household and community levels. Where value addition is practiced (e.g., milk-processing; soybean processing, etc.) in the intervention communities, it is mostly done by women using traditional, outmoded, and time consuming methods which increase the work-load of women and result in low-quality products with limited shelf-life.

Socio-economic and biophysical activities will be implemented with public and private sector partners to evaluate and demonstrate best practices for reducing post-harvest losses in maize, cowpea and

[14] Spurgeon, D., 1976. Hidden harvest: a systems approach to postharvest technology. IDRC, Ottawa, ON, CA.

groundnut. Small-scale, post-harvest labor-saving machinery (shellers, fodder choppers) and post-harvest products (e.g., Super Grain Bags, PICS bags, Collapsible Dryer Case and Sil bags) will be evaluated against farmers' current practice in the Africa RISING intervention communities in the three regions. Male and female farmers' preferences, labor and time saved by the introduction of a technology will be recorded. Cost-benefit ratio of using the technology will be determined.

Equal numbers of female farmers and male farmers will be considered when selecting farmers for field trials. Female AEAs with outstanding field performances will be given priority and selected for training workshops to on their turn train farmers in best post-harvest practices. Further, female experts in the field of post-harvest research in Ghana and elsewhere will be invited from time to time as consultants to assist with the implementation and, female students with interest in research on post-harvest management will also be given equal priority as male students for further training.

The protocol covers activities 2.2.1 and 2.2.2 in the Africa RISING West Africa Project Phase 2 logframe.

Sub-activity GH221-1701: Exploring willingness to pay for small scale maize shelling machines - Leader: Bekele Kotu

Mechanization is an important complement, and in some cases a necessary condition, to agricultural intensification. It constitutes several implements and machines which can substitute or supplement human labor to carry out energy/power intensive operations (such as land preparation, harvesting and threshing) as well as control intensive operations (such as planting and weeding) (Pingali, 2007[15]). While agricultural mechanization played a great role during the Asian green revolution, current scholarly opinions indicate that mechanization can play even a better role to intensify African agriculture because of the fact that land-to-labor ratio is relatively high in many African countries such as Ghana, Tanzania, Nigeria, Senegal, and Zambia (Nin-Pratt and McBride, 2014[16]). That is, when existing land has to be more intensively cultivated, mechanization will be adopted to complement the higher labor demand to accomplish increased activities. Secondly, there are also arguments that agricultural operations are arduous by their nature and mechanization is necessary to reduce the drudgery. Drudgery has increasingly become important to explain the opportunity cost of labor, particularly for the youth, who can otherwise be engaged in less laborious urban based employments although they may be less productive (Mrema et al., 2008[17]). Most of the laborious activities such as manual threshing are usually carried out by women and hence the adoption of mechanization may improve the welfare of women. Thirdly, the adoption of mechanization can also reduce harvest and postharvest grain losses. For instance, a study indicates that the use of a combine harvester could reduce grain losses by 20-35 percent as compared to manual threshing (Hassena et al., 2000[18]).

Despite these potential advantages of mechanization, humans are the main power source for agricultural production in sub-Saharan Africa (Diao et al., 2016[19]). Until recently the use of engine-powered machines has been limited to a few countries in this region and where mechanized farms

[15] Pingali, P. (2007). Agricultural Mechanization: Adoption patterns and economic impacts. In: R. Enanson and P. Pingali (eds.), Handbook of Agricultural Economics, volume 3, pp. 2780-2803. Elsevier B.V.

[16] Nin-Pratt, A., and McBride, L. (2014). Agricultural Intensification in Ghana: Evaluating the Optimist's Case for a Green Revolution. *Food Policy*. 48: 153–167.

[17] Mrema, G., Baker, D., and Kahan, D. (2008). Agricultural Mechanization in Sub-Saharan Africa: Time for a New Look. Rome: Food and Agriculture Organization of the United Nations.

[18] Hassena et al., 2000. *A comparative assessment of combined harvesting vis-à-vis conventional harvesting and threshing in Arisi region, Ethipioa.* Mexico, DF: International Maize and Wheat Centre (CIMMYT) and Ethiopian Agricultural Research Organzation (EARO)

[19] Diao, X, Silver, J. and Takeshima, H. (2016). Agricultural Mechanization and Agricultural Transformation. International Food Policy Research Institute (IFPRI), Discussion paper #01527.

exist they are definitely large-scale commercial farms. In fact, smallholder farmers who contribute to the large part of the total production in these countries are out of reach of mechanization. This can be partly attributed to the failure of state-led mechanization schemes in several African countries in the 1970s and 1980s due to lack of demand among farmers (Pingali, Bigot, and Binswanger, 1987[20]). Nevertheless, evidence indicates that situations are changing and the demand for mechanization may have begun to emerge in some parts of Africa in recent years, promoting a renewed focus on mechanization (Mrema et al., 2008). The demand for mechanization emerges at a point when it becomes cost-effective to use it instead of other available options. Thus, policy and development interventions aimed at promoting mechanization must first confirm whether sufficient demand for mechanization is present.

Small motorized maize shelling machines increase the labor efficiency among smallholder farmers while saving costs. Initial results of our earlier study in northern Ghana show that farmers can save on average 36 hours per ton of maize shelled if they use the diesel operated machine instead of the manual method they are using at present. They can save about 28 hours if they use electric operated machines. The time saved is equivalent to 40 GHS and 30 GHS per ton for the diesel and electric shellers, respectively. These results show that the potential demand for the technologies will be high if the machines are promoted. However, there is no concrete evidence on how much farmers are willing to pay for the new technologies and which factors affect the level of payments. Therefore, this study is initiated to fill this gap. Scientific evidence on farmers' willingness to pay and associated factors is useful particularly to stakeholders operating on the supply side of the market.

2. Objectives

2.1. To create awareness on the maize shelling machines among small scale farmers

2.2. To quantify how much farmers are willing to pay for the maize shelling machines (or their services) if the market makes the machines (or their services) available to them

2.3. To identify factors affecting willingness to pay among the farmers

3. Research questions

3.1 How much are farmers willing to pay for the machines or their services?

3.2 What are the factors influencing farmers' willingness to pay for the machines or their services?

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)

The study will involve a household survey which will be conducted in August 2017. It will cover a total of 600 households in 13 communities. The purpose of this survey is to assess the willingness of the farmers to pay for the machines and their services. Data will be collected on the amounts farmers are willing to pay, household demography, labor use, income and assets, maize production, experience in mechanization (including maize shelling machines) and others. In addition to the household surveys, key informant interviews will be conducted with 2-3 agric-machinery dealers and at least one agricultural expert in the study districts. The purpose of key informant interviews is to explore the supply chains for agric-machineries and associated policy environment.

5. Data to be collected and uploaded	Responsibility/Institute
Data will be collected on farmers' willingness to pay for maize shelling machines, household demography, labor use, income and assets, maize	Bekele Kotu/IITA

[20] Pingali, P., Bigot, Y. and Binswanger, H. (1987). *Agricultural Mechanization and the Evolution of Farming Systems in Sub-Saharan Africa.* Baltimore: Johns Hopkins University Press.

production, experience in mechanization (including maize shelling machines) and others	

6. Milestones		
Deliverables	Means of verification	Date
6.1 Awareness created among farmers on maize shelling machines	Attendance reports of demonstration event and pictures the events	Apr. 2017
6.2 Instruments developed and programmed	Sample of instrument available	Jul. 2017
6.3 Second survey completed	Reports and completed survey questionnaire	Aug. 2017
6.4 Data cleaned, and initial results reported	Poster, Technical report	Sep. 2017

7. Sustainable intensification indicators	
7.1 Productivity	Shelled output per unit of labor input and time per household
7.2 Environmental	
7.3 Economic	Cost per unit of output, cost saved per unit of output, stated demand
7.4 Social	Participation rate by gender, labor saved by gender
7.5 Human	Drudgery score

Sub activity GH221-1702: Evaluate and demonstrate options to reduce post-harvest losses in stored cereal and legumes - Leader(s): Adebayo Abass and Asamoah Larbi
2. Objectives
2.1 Compare and demonstrate different storage methods (e.g., silos, hermetic plastic tanks)
2.2 Compare and demonstrate different drying methods
2.3 Document gender preferences for postharvest technologies and practices
3. Research questions/hypotheses
3.1 Post-harvest losses in cereal and legume grains are significantly affected by storage and drying methods
3.2 Male and female farmers have similar preferences for post-harvest storage and drying
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
On-farm trials will be conducted to evaluate, adapt and disseminate storage technologies to reduce post-harvest losses in stored grain, especially maize, groundnut and cowpea. Most of the on-farm studies will use a randomized complete block design (RCBD) with communities as blocks and households as replicates, and farmers' current practices as controls. The trials will be conducted in 6 communities with 10-20 households per treatment based on the size of the community over 12-18 months period. Data to be collected every two months will include: pest infestation, volume per weight loss, quality losses (physical, biochemical, nutritional, economic), aflatoxin levels and farmers' perceptions. Capacities of farm families and development partners will be strengthened to reduce post-harvest losses.
Sub-activity GH221-1702-1: On-farm comparison of storage technologies to prevent stored-product insect infestation of maize - Leaders: Adebayo Abass, Asamoah Larbi and Kofi Danso
1. Actellic Super treated maize in 50 kg polyethylene bags (poly sacks) 2. Untreated maize in 50 kg polypropylene (PP) bags and 3. Untreated maize in 50 kg Super Grain Bags (GrainPro) 4. Untreated maize in 50 kg PICS bags

Sub-activity GH221-1702-2: On-farm evaluation and demonstration of silos for grain storage: Leader(s): Adebayo Abass, Asamoah Larbi and Kofi Danso

1. Farmer's silo
2. Modified farmer's silo
3. 1-ton GS4 Silo bags

Sub-activity GH221-1702-3: Evaluate, adapt and disseminate driers - Leader(s): Adebayo Abass, Asamoah Larbi and Kofi Danso

New post-harvest products will be purchased and demonstrated with farmers' practices as control. Potential products to be evaluated include:

1. Super Grain Bags (SGB IV-R)
2. Collapsible Dryer Case
3. Sil bags

5. Data to be collected and uploaded	Responsibility
5.1 Pest infestation	IITA/SARI
5.2 Volume per weight loss	IITA/SARI
5.3 Quality losses	IITA/SARI
5.4 Aflatoxin levels	IITA/SARI

6. Milestones

Deliverables	Means of verification	End date
6.1 A post-harvest team is established	Field visit and project report	Apr. 2017
6.2 Post-harvest options identified	Project reports	Apr. 2017
6.3 Communities are identified trial inputs purchased	Project reports	Jul. 2017
6.4 Post-harvest trials established	Field visits project reports	Oct. 2017
6.5 At least 300 farmers exposed to new options	Project report and field visit	Aug. 2017
6.5 Peer reviewed paper: "Comparison of post-harvest storage methods for cowpea and maize grains"	Journal of stored products	Mar. 2019

7. Sustainable intensification indicators

7.1 Productivity	Crop yield at the farm and household levels
7.2 Environmental	Pesticide use at the household level
7.3 Economic	Profitability and input use efficiency at the farm and household levels
7.4 Social	Gender equity at the farm and household levels
7.5 Human	Production of nutritious food and food production at the household level

8. How will scaling be achieved?

Farmers' field days will be organized to create awareness among farmers about the post-harvest technologies and practices; ensuring the supply and/or availability of the technologies and practices; facilitating credit for the purchase of the technologies and practices; and encouraging farmers' groups to be engaged in the provision of services related to the technologies and/or practices.

9. How are the activities in this protocol linked to those of others?

Linked to protocols GH111A-17 and GH111B-17.

10. Budget (US$)	Sub-activity GH221-1701[2]	Sub-activity GH221-1702[1]
Personnel	18,000	76,000
Services	2,000	52,000
Supplies	2,000	28,000
Capital	0	0
Travel	3,500	14,000
Overhead	0	0
Total	25,500[2]	170,000[1]

[1]Includes cost of staff, project offices, vehicle running and maintenance of the 25 intervention communities in the Northern (Tamale), Upper West (Wa) and the Upper East (Navrongo) regions.
[2] Budget assigned separately by Project Manager to project socio-economist, and therefore not included in the consolidated budget.

2017 Africa RISING West Africa Activity Protocol – Outcome 3: GH311-17				
Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies.				
a. Output: 3.1	Enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policy makers and development partners			
b. Activity: 3.1.1	Review existing policies and institutional arrangements affecting equitable access to production assets and markets			
c. Sub-activity: GH311-17	Review and compile gaps and dysfunctionality in SI policies and institutions (norms, rules and practices) of SI at target areas and enhance farmer access to credit and markets			
d. Research team				
Name	Institution	Role		
Charity Osei	STEPRI	Policy analysis		
Clara Anim Nyarkoah	FOSTERING	Establishment of cooperatives and linkages to markets		
Bekele Kotu	IITA	Economic evaluation		
Jimah Kipo	IITA	Gender analysis		
Shaibu Mellon	IITA	Economic evaluation		
Joab Darkwa	FOSTERING	Field supervision and research		
Emmanuel Awuni	FOSTERING	Cooperative Development		
e. Student(s)				
Name	Institute	Degree	Start	End
f. Location(s)	Duko (Northern), Nyangua (Upper East) and Zanko(Upper West)			
g. Start	May 2017			
h. End	Dec. 2018			

1. Justification
Policy and institutional contexts influence the success of scaling-up projects. It is therefore crucial to first understand the different formal policy and informal local institutional contexts to be able to formulate strategic dissemination and scaling-up/out models to ensure sustainable adoption of the generated sustainable intensification technologies and practices. The research findings will also provide inputs for the formulation and adoption of national agricultural policies, and how to reorganize local market institutions with a focus on the use of sustainable agricultural intensification approaches to address food insecurity in Northern Ghana. Access to financial services is critical to provide funds for farm investments in productivity, improve post-harvest practices, smooth household cash flow, enable better access to markets and promote better management of risks. Access to finance can also play an important role in climate adaptation and increase the resilience of agriculture to climate change, thus contributing to longer term food security. Access to a comprehensive range of financial services is a significant challenge for smallholders, who constitute the vast majority of farmers in the three northern regions. Farmers' decisions to invest and to produce are closely influenced by access to financial instruments. If appropriate risk mitigation products are lacking, or if available financial instruments do not match farmers' needs, farmers may be discouraged to adopt better technologies, to purchase agricultural inputs, or to make other decisions that can improve the efficiency of their businesses. Improving access to finance can increase farmers' investment choices and provide them with more effective tools to manage risks. We want to ascertain whether access to finance would influence adoption of the technologies promoted by Africa RISING.
2. Objectives
2.1 Identify gaps in existing agricultural policies (with focus on sustainable intensification), and diagnose the institutional conditions prevalent in markets and adoption of new technologies
2.2 Assess the impact of credit provision to adoption of the technologies promoted by Africa RISING
3. Research questions
3.1 What SI policies exist in the current national agricultural policy document, what are the gaps and dysfunctionalities; and what institutional conditions (norms, rules and practices) exist in the target areas, input and output markets and how do these contexts influence households/farmers adoption of SI packages?
3.2 Does access to credit contribute to adoption of the technologies promoted by Africa RISING?
3.3 What factors influence farmers' decisions on loan allocations?
3.4 What factors influence the demand for credit?
3.5 What is the role of farmer based organizations in farmers' access to credit?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
Sub-activity GH311-1701: Review and compile gaps and dysfunctionality in SI policies and institutions (norms, rules and practices) of SI at target areas - Leader: Charity Osei
Desk review of national agricultural policies, to be triangulated with key informants and personal interviews. A survey designed to capture gender-disaggregated and farmer types data will be conducted, and validated with key informants, personal interviews, participant observations and focus group discussions
Sub-activity GH311-1702: Enhancing farmer access to credit and markets - Leader(s): Clara Nyarko
The study will be conducted in nine Africa RISING intervention communities, three from each region. It will involve focus group discussions and individual interviews to collect gender-disaggregated data on

the role of credit access to adoption of technologies promoted by the Africa RISING project. Three treatments will be used:
(i) Farmers who have access to credit only;
(ii) Farmers who have access to credit with training on financial literacy;
(iii) Control (i.e., farmers who do not have access to neither credit nor training)

The treatment will be assigned to households in two stages:
Stage 1: 9 Communities (3 from each region) will be assigned to treatments randomly
Stage 2: One Household will be sampled randomly from each of the nine communities. All sample households will take the treatment assigned to their community. Assignment of the treatment to each household would depend on whether or not that household fall within the treatment categories stated above

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Secondary and primary quantitative and qualitative data on policy gaps and dysfunctionality; enabling/constraining institutional conditions	STEPRI
5.2 Secondary and primary quantitative and qualitative data on credit accessibility and its impact to adoption of the technologies promoted by Africa RISING	FOSTERING

6. Milestones

Deliverables	Means of verification	Date
6.1 Policy gaps, dysfunctionalities and local institutional conditions reviewed	Interview guides; tape recorded and transcribed information and pictures and videos, project technical and financial reports	Aug. 2017
6.2 Report on effect of access to credit and markets on adoption	Uploaded report on CKAN	Dec. 2017
6.3 Paper in edited proceedings - 'Gaps in policies and institutions affecting sustainable intensification'	Paper in edited workshop proceeding	Dec. 2018

7. Sustainable intensification indicators

7.1 Productivity	
7.2 Environmental	
7.3 Economic	Profitability and input use efficiency at farm and household level
7.4 Social	Gender equity at farm and household level
7.5 Human	

8. How will scaling be achieved?

Scaling will be achieved by first identifying agricultural based (particularly those with stakes in sustainable intensification) development partners, private and public sector organizations; then disseminating insights and success stories from research findings through knowledge-sharing events; getting buy-in; and facilitating communities of practice activities to enhance adoption and implementation of findings in diverse context.

9. How are the activities in this protocol linked to those of others?

Linked to protocols GH111A-17, GH111B-17, GH321-17 and GH4123-17. The activities in this protocol mainly focus on markets, institutions, policies and adoption of new SI technologies. These activities link directly to most others which seek to generate new SI technologies and practices. In that sense, our activities will help to unravel insights on how the generate technologies and practices are adopted, within what contexts, and how access to input and output markets are achieved. Mostly, the activities will lead to forming alliances to promote scaling up of technologies generated from other activities.

10. Budget (USD)		
Budget Line	STEPRI	FOSTERING
Personnel	5,000	3,000
Services	5,000	4,000
Supplies	4,000	0
Capital	3,000	0
Travel	5,000	2,000
Overhead	3,000	1,000
Total	25,000[1]	10,000[2]
[1,2]Contract STEPRI for US$ 35,000. STEPRI to disburse US$ 10,000 to FOSTERING		

2017 Africa RISING West Africa Activity Protocol – Outcome 3: GH312-17				
Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies				
a. Output: 3.1	Improved policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policy makers and development partners			
b. Activity: 3.1.2	Assess the level of inclusiveness of women and the youth along crop and livestock value chains			
c. Sub-activity: GH312	Explore value chain options engaged in by men, women and the youth			
d. Research team				
Name	Institution	Role		
Kipo Jimah	IITA	Leader		
Gundula Fischer	IITA	Member		
Prince Kwesi Otabil	IITA	Member		
e. Student(s)				
Name	Institute	Degree	Start	End
1.				
2.				
3.				
f. Location(s)	6 project communities (Zanko and Goriyiri in UWR, Botigoli and Cheyohi in NR, Nyangua and Tekuru in UER)			
g. Start	April 2017			
h. End	February 2018			
1. Justification				

Development of agricultural value chains is being considered a priority for transforming smallholder agricultural production systems (IFPRI, 2007)[21]. A value chain describes the full range of activities in the production process that are required to bring a product or service from conception through the intermediary phases of production and delivery to final consumers (Kaplinsky and Morris, 2000)[22]. Rubin et al (2008)[23] describe value chain analysis as the process of documenting and analyzing the operation of a value chain. This involves the mapping of chain actors and calculating the value added to a product along the chain. For Riisgaard et al (2010)[24], a value chain analysis provides the opportunity for actors in a production process to understand each other's functions and the activities involved and to identify and correct barriers and gaps that cause inefficiencies in the production process.

While value chain analysis is not new, integrating gender in value chain analysis is more recent (Kruijssen et al. 2016)[25]. In Ghana, women occupy an important place in agricultural production. Women are engaged in various activities in the production and distribution process including adding value to the product and the provision of logistical support to ensure the product reaches the end user. It is reported that women constitute 52% of agricultural labor, 70% in food crops productions, 95% in agro processing, and 85% in food distribution (SEND-Ghana, 2014)[26]. Yet, women are often not considered 'visible actors' in the agricultural production chain. Gender issues need to be integrated in value chain analysis for the purpose of understanding women's and other population subgroups' position in a value chain, the effect of changes in a value chain on gender inequality and the main constraints for women in terms of gaining from value chain participation (Mutua, E. et al. 2014)[27].

Under phase 1 of Africa RISING, limited value addition to improve quality in crops and livestock products at the household and community level in Northern Ghana was reported. For this reason the need for research on post-harvest and value addition has been emphasized in phase 2 (IITA, 2016, phase 2 proposal, pg. 10)[28]. As Africa RISING continues to support farmers to increase agricultural production through the introduction of technologies, it is important to understand the activities of all actors and the relationship between various actors in the production and distribution, as well as the

[21] IFPRI (2007). Smallholder Agriculture in Ghana. Ghana Strategy Support Program-IFPRI Discussion Brief 3. Available at http://www.ifpri.org/themes/gssp/gssp.htm [Accesses on 19/06/2017]

[22] Kaplinsky and Morris (2000). In Mutau et al. (2014) In: Mutua, E., Njuki, J. and Waithanji, E. 2014. *Review of gender and value chain analysis, development and evaluation toolkits.* Nairobi, Kenya: International Livestock Research Institute (ILRI).

[23] Rubin et al. (2008). In: Mutua, E., Njuki, J. and Waithanji, E. 2014. *Review of gender and value chain analysis, development and evaluation toolkits.* Nairobi, Kenya: International Livestock Research Institute (ILRI).

[24] Riisgaard, L., Fibla, A. and Ponte, S. (2010). Gender and value chain development. Copenhagen, Denmark: Danish Institute for International Studies

[25]Kruijssen, F., Paula Kantor, P., Alessandra Galie and Rozel C. F, 2016. Adding gender transformation to value chain analysis In: Pyburn, Rhiannon, and Anouka van Eerdewijk (eds). *A different kettle of fish? Gender integration in livestock and fish research*. LM Publishers, Volendam

[26] SEND-Ghana (2014). Women and smallholder agriculture in Ghana. Policy brief No. 4. October http://www.sendwestafrica.org/phocadownload/Women%20and%20Smallholder%20Agriculture%20in%20Ghana%20Policy%20Brief%20-%20Copy.pdf?lbisphpreq=1 [Accessed on 19/06/2017]

[27] Mutua, E., Njuki, J. and Waithanji, E., 2014. *Review of gender and value chain analysis, development and evaluation toolkits.* Nairobi, Kenya: International Livestock Research Institute (ILRI).

[28] IITA, 2016. West Africa Regional Project: Proposal for second phase, 2016-2021, pg. 10.

control and use of benefits that accrue from participating in the production and distribution processes (Kruijssen et al. 2016).

Coles and Mitchell (2011)[29] identify the potential of a value chain approach to analyze men and women's participation at every stage of agricultural value chains and that a gendered value chain analyses should include intra-household and institutional level analysis (Coles and Mitchell, 2011). The research will adopt a gender transformative value chain analysis approach. A gender transformative value chain analysis approach will provide an understanding of crops and livestock value chains opportunities available in the project communities, reveal the effects of social norms that create inequalities between men and women within and across the various stages in a value chain, the nature and barriers to entry that constrain the ability of women and the youth to use existing crops and livestock value chains opportunities to build their livelihoods. Part of this research will be awareness creation not only to improve women's access to resources but also to help communities to understand and challenge the social norms that create inequalities between men, women and the youth.

2. Objectives

2.1 To explore value chains options engaged in by men, women and the youth in project communities

2.2 To assess the opportunities, constraints and needs of men, women and the youth in participating in one selected value chain

3. Research questions

3.1 What are the different value chains in project communities that men, women and youth participate in?

3.2 What are the opportunities, constraints and needs of men, women and the youth in participating in one value chain to be selected?

3.3 How are the opportunities, constraints and needs gendered in this particular value chain?

4. Procedures

The study will use both qualitative and quantitative approaches. Desk review of relevant documents, a rapid appraisal and discussions with NGOs will be conducted to gain an overview on value chains options. The results of the overviews will inform the development of an interview guide for focus group discussions with men, women and the youth on a selected value chain. The data from the overview and FGD will inform the development of questions for individual interviews (360 individual interviews, 60% female) and key informant interviews. There will be a feedback and it will take two forms. The first feedback will comprise of relevant actors and selected individuals from R4D platforms to validate the results. The second will be communitywide sensitization on gender equality issues that will incorporate the results of the study in the research communities targeting 300 participants (60% females).

A list of Africa RISING project beneficiaries in sampled communities will constitute the sample frame. A random sampling process will be used to select 60 households as the primary sample and 24 households as a secondary sample. Three household members, the household head, the spouse and an adult member of the household preferably a youth (a person of 15-35 years (GOG/MY&S, 2010[30])) will be interviewed. In the case where it is female-headed household, a male and a female will be interviewed in addition to the household head. In a situation where there are no additional household members to be interviewed, a household from the secondary sample be used.

[29]Coles, C. and Mitchell, J., 2011. *Gender and agricultural value chains: A review of current knowledge and practice and their policy implications.* FAO, ESA Working Paper No. 11. Rome, Italy: FAO.

[30] GOG/MY&S, 2010. National Youth Policy of Ghana: Towards an empowered youth, impacting positively on national development. Ministry of youth and sports, Ghana.

Key informants will be identified through deskwork and during rapid appraisal in the selected communities.		
5. Data to be collected and uploaded		Responsibility/Institute
5.1 Secondary and primary quantitative and qualitative data		Kipo Jimah, IITA
		Research assistants from UDS
6. Milestones		
Deliverables	Means of verification	Date
6.1 Desk review by Kipo Jimah	Interview guide, transcribed notes on consultations	Apr./May 2017
6.2 Scoping trip to surveys communities carried out, study instrument developed and consultations with NGOs on value chain development held by Kipo Jimah	Interview guide, transcribed notes on scoping trip, study instruments	Jun. 2017
6.3 Conduct focus group discussions by Kipo Jimah and Prince Otabil	Transcribed notes	Jul. 2017
6.4 Enumerators recruited and trained by Kipo Jimah and Gundula Fischer	Advert, training module, attendance	Aug. 2017
6.5 Crops and livestock values chains in surveyed communities mapped; constrained and needs assessed by Kipo Jimah and Prince Otabil	Transcribed notes, pictures; data sets from administered questionnaires	Sep. 2017
6.6 Validation meeting held by Kipo Jimah and Prince Otabil	Validation meeting report	Oct. 2017
6.7 Employ findings from research to create awareness on gender equality issues to be led by Kipo Jimah and Prince Otabil	Report on community awareness training	Nov./Dec. 2017
6.8 Study report written by Kipo Jimah, Prince Otabil and Gundula Fischer	Poster, Technical report	Feb. 2018
7. Sustainable intensification indicators		
7.1 Productivity		
7.2 Environmental		
7.3 Economic	Market participation by gender	
7.4 Social	Gender equity- access to resources for participation in value chain	
7.5 Human		

8. How will scaling be achieved?	Through the community awareness creation on gender equality using findings of the research. Also use of R4D platforms and project engagements with farmers and partners
9. How are the activities in this protocol linked to those of others?	The activity in this protocol is linked to activities under the outcome 3--improved policies and institutional arrangements to increase participation of farm families, especially women and youth in output and input markets and decision-making. For the West African project, a similar study will be conducted in the Koutiala area in Mali.

10. Budget[1] (USD)	
Budget Line	Amount
Personnel	6,375
Services	3,400
Supplies	810
Travel	5,400
Overhead	0
Total	15,985
[1] Budget will come from Africa RISING Gender Specialist's WA budget cc5839	

2017 Africa RISING West Africa Activity Protocol – Outcome 3: GH321-17				
Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies.				
a. Output: 3.2	Output 2: Options to increase access to production assets and increase participation in decision-making by women, youth and other vulnerable groups			
b. Activity: 3.2.1	Identify constraints to and opportunities for increasing women and youth access to production assets/decision making in the target area			
c. Sub-activity: GH321-17	Analyze intra-household differences and decision-making for adoption			
d. Research team				
Name	Institution	Role		
Jeroen Groot	WUR	Farming systems analysis (Activity Leader)		
Katrien Descheemaeker	WUR	Farming systems analysis		
Carlo Azzari	IFPRI	Typology analysis		
Bekele Kotu	IITA	Economic analysis		
Gundula Fischer	IITA	Gender assessment		
Kipo Jimah	IITA	Gender assessment		
e. Student(s)				
Name	Institute	Degree	Start	End
Thibault De Moor	WUR	MSc	2017	2017
Mirja Michalscheck	WUR	PhD	2014	2018
f. Location(s)	Duko (Northern Region), Nyangua (Upper East), Zanko (Upper West)			
g. Start	February 2017			
h. End	December 2017			
1. Justification				
The second phase of Africa RISING is about scaling up 'successful technologies'. For scaling up it is important to know the target farms and farmers, since farming systems are diverse and not all technologies are equally suitable for each farm household and their household members. We know that different household members have different roles and interests (production orientation) as well as				

power positions (assertiveness). Interests and power positions, together, result into farm decisions. Together, all farm decisions result into one specific farm configuration (land and labor allocation, cropping pattern) per season. Hence, each farm configuration is associated to a certain degree of satisfaction for each household member. A change in farm configuration may benefit one household member and adversely affect another. We currently do not understand well the intra-household trade-offs associated to alternative farm designs for sustainable intensification. This piece of information is an innovative and highly valuable addition to the exploration of technical possibilities (alternative farm configurations) as determined in the whole-farm model Farm DESIGN. Since Africa RISING wants women and children to benefit from their technologies (improved agronomic practices), we argue that a deeper look into the household is indispensable to understand scaling possibilities as well as possible impacts per technology.
2. Objectives
2.1 Identify individual curves of satisfaction (per household member) associated to different farm configurations, mainly land allocation to different crops. Show intra-household trade-offs
2.2 Quantify and explain differences among different household members concerning their 'curves of satisfaction'
2.3 Make use of typologies e.g. by comparing the technical and social performance of different traction methods per farm type in Duko (Northern Region) and Nyangua (Upper East Region)
3. Research questions
3.1 What are the intra-household trade-offs associated with alternative farm designs for sustainable intensification?
3.2 Do different household members evaluate the different AR technology packages differently? If yes: on what aspects do perceptions differ? And what can be concluded for technology targeting/scaling?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1 Individual (and separate) farmer interviews with minimum one female and one male adult per case study household (n=9 households). Method: a gaming approach with leafs or pebbles serving to express the degree of satisfaction (ranging from 0-10, 0= not satisfied; 10= highest satisfaction possible). The approach has been tested during field visit in August 2016.
4.2 For contextualization: further interviews of same style (>5 per farm type in each case study community) to check for patterns per farm type.

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Per variable (e.g. land allocation to maize) we capture one 'range of values' (expressing satisfaction) per household member. The results of all household members will be 'pooled' in one Excel table and the results will jointly be presented in a line chart. Further visualizations may be added. Data for all variables, all households and household members will be made available to AR colleagues on CKAN. Data must not be fully unlocked/used by anyone else than the authors until published in a peer reviewed journal article	Mirja Michalscheck/WUR

6. Milestones

Deliverables	Means of verification	Date
6.1 Journal article: Model results versus farmer realities.	Submitted for publication	Dec. 2017

Operationalizing diversity within and among smallholder farming systems for a nuanced impact assessment		
6.2 Master Thesis (WUR)	Uploaded document	Aug. 2017

7. Sustainable intensification indicators	
7.1 Productivity	Crop and livestock yield at the farm and household levels
7.2 Environmental	Soil health at the farm and household level
7.3 Economic	Profitability and input use efficiency at the household level
7.4 Social	Gender equity at the farm and household levels
7.5 Human	

8. How will scaling be achieved?	
Existing typologies (e.g. Signorelli, 2016[31]) may serve to broadly test the validity of identified intra-household patterns per farm type. Knowledge about intra-household differences (and trade-offs) may sensitize/improve ongoing scaling efforts, minimizing intra-household trade-offs.	

9. How are the activities in this protocol linked to those of others?	
Linked to protocols GH111A-17 and GH311-17.	

10. Budget (USD)	
Budget Line	
Personnel	15,000
Services	2,000
Supplies	1,000
Capital	0
Travel	2,500
Overhead	4,500
Total	25,000[1]
[1]Contract WUR	

2017 Africa RISING West Africa Activity Protocol – Outcome 4: GH4123-17	
Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI technologies, innovations and practices.	
a. Output: 4.1	Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale
b. Activity: 4.1.2&3	Map and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling delivery of validated technologies. Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways.

[31] Signorelli, S. 2016. Typology characterization of farmers in West Africa. Presented at the Africa RISING West Africa Review and Planning Meeting, Accra, 30 March–1 April 2016. Washington, D.C.: IFPRI.

c. Sub-activity: GH4123-17	Promote partnerships for large-scale delivery of technologies/practices

d. Research team and scaling partners[1,2]

Researchers	*Institution*	*Role*
Asamoah Larbi	IITA	Partnership establishment and coordination of activities
Isaac Kankam Buadu	ADRA	Partnership establishment and scaling
Charity Osei	STEPPRI	Policies and institutions
Abdul Nurudeen	IITA	Cereal agronomy and plant nutrition
Shaibu Melon	IITA	Economic analysis
Kipo Gimah	IITA	Gender studies
Kofi Danso	IITA	Post-harvest management
Saaka Buah	SARI	Plant nutrition and soil science

[1]National development partners: ACDEP, CFC, CRS, INSTI, RING, ADVANCE II, ATT, Urban Network, TRIAS Ghana, ProNet, Project, AMSIG Marketing Company, Food Security through Cooperative in Northern Ghana Project, Savanna Agricultural Development Agency, MTN-Ghana, Vodaphone-Ghana, Farm Radio International, Local Councils, District Assembly, Regional Coordination Councils, Rural Bank, Agricultural Development Bank, Gees Fresh Point, Poultry Farmers Association (Bolga, Wa and Tamale), Vision Farms, Parliamentarians, Input Dealers, Animal Breeding Stations (Kpong Tamale, Paga, Babile), Seed Producers Association of Ghana, Animal Production Division, Veterinary Services, Grains and Legumes Development Board, Youth Harvest.

[2]International development partners: Adventist Development and Relief Agency, Farm Radio International, Aga Khan Foundation, CARE International (Ghana), Plan Ghana, Grameen Foundation, Catholic Relief Services, Social Enterprise, Netherlands Development Organization, World Food Program, World Vision, Camfed, Canada Funds for Children, Oxfam.

e. Student(s)

Name	Institute	Degree	Start	End

f. Location(s)	Africa RISING intervention communities in Northern, Upper East and Upper West regions; and communities of Africa RISING partners involved in scaling-out technologies
g. Start	June 2017
h. End	March 2018

1. Justification

In Phase 1, country-based regional/district coordination teams implemented generic research on technology identification, testing, and validation in partnership with district and community-based research-for-development platforms primarily consisting of disciplinary experts in the public sector and farmers. Ad hoc dissemination and scaling arising from technology generation and demonstration activities targeted a few (less than 5,000) direct beneficiaries who were engaged in the technology development/validation resulting in high cost per beneficiary. Monitoring and evaluation was mostly quantitative, with no beneficiary tracking system to capture formal / informal technology dissemination.

Phase 2 proposes to disseminate proven technologies and practices from Phase 1 in collaboration with development partners to reach more than 90,000 households. Thus, there is need to develop briefs to describe the technologies and practices developed in Phase 1; expand the multi-stakeholder

partnerships to include more private sector and development actors; establish multi-stakeholder interest groups for specific SI innovations at the community and district levels; build the capacity of the partners for scaling-out the technologies/practices; scale-out the SI innovations with the development partners and interest groups; and develop a tracking system capture the beneficiaries. This protocol covers activities 4.1.2, 4.1.3 and 4.4.1 in the Phase 2 project logframe (Table 1). It builds on the ad hoc technology dissemination and scaling-out/up in Phase 1. Budget for activities under this protocol will be derived from the dissemination budget.
2. Objectives
2.1 To identify stakeholders engaged in agricultural development and agribusiness in the project area and explore potential for partnership in research-in-development
2.2 To facilitate institutional arrangements and partnerships at the community, district and regional levels for technology dissemination
2.3 To identify proven technologies and practices from Phase 1 that can be scaled-out in Phase 2, and develop technology briefs to describe them
2.4 To build capacity of stakeholders to disseminate validated technologies and/or practices to thousands of households
2.5 To review existing scaling-out/up models or pathways and institutional arrangements to reach out to thousands of households
2.6 To establish knowledge-sharing and learning alliances among scaling actors
2.7 To facilitate large-scale use/adoption of technologies identified in Phase 1
2.8 To develop a monitoring system to track and capture beneficiaries
3. Scaling /issues
3.1 Who are the potential public and private sector research-in-development partners in the project area; and which of them have the potential to deliver validated technologies and practices to thousands of households?
3.2 What type(s) of partnership and institutional arrangements could be initiated to ensure effective scaling-up/out of the validated technologies and practices, especially reaching out to women and youth?
3.3 What are the validated technologies and practices identified from Phase 1 that can be scaled-out in Phase 2?
3.4 What scaling models/pathways exist, and which will be appropriate for the various technologies and practices?
3.5 What strategies can be used to strengthen their capacities to disseminate technologies and/or practices to thousands of beneficiaries?
3.6 How can primary and secondary beneficiaries be tracked to ensure targets are reached?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
Sub-activity GH4123-1701: Promote multi-stakeholder partnerships for technology development and dissemination - Leader(s): Asamoah Larbi et al.
Mapping of potential research and development partners for engaging in Phase 2 of the WA project which started in Phase 1 will continue. Potential partners identified during the initial mapping (see Table 5 of the WA Phase 2 project proposal), and new ones will be visited to discuss partnership arrangements for scaling-out/up technologies. Mobilization, sensitization and documentation of beneficiary households in the intervention communities which started during Phase 1 will continue in all the regions. Five new communities in

Binduri district will be identified and mobilized. The existing list of beneficiary households in each community will be updated and geo-referenced. New beneficiary households will be enlisted. Community-based organizations, women's interest groups, and youth associations in each community and their objectives will be documented.

The research-for-development platforms implemented at the community and district levels will be replaced by multi-stakeholder interest groups for a specific SI innovation at the community and district levels (see Table 3 in the WA Phase 2 proposal). The partners and interest groups will be used to identify and disseminate validated technologies and practices, promote knowledge sharing and dissemination, and establish knowledge-sharing and learning alliances among scaling actors.

Sub-activity GH4123-1702: Identify and describe validated technologies - Leader(s):- Asamoah Larbi et al.

The Chief Scientists will circulate the WA project template for technology description to all scientists and activity leaders for the second time in May 2017 for them to describe their validated technologies and/or practices in Phase 1, as well as any other proven technologies/practices that can be scaled-out in Phase 2. The Chief Scientist will send the completed technology description templates for expert review. Thereafter, the briefs will be forwarded to the Communication Specialist for review and publishing.

Sub-activity GH4123-1703: Scale-out validated technologies with multiple partners - Leader(s): Asamoah Larbi et al.

Validated technologies in the Guinea Fowl and Maize-Legume (cowpea, soybean and groundnut) rotations and intercropping (Table 2) will be disseminated under the leadership of ADRA. A 2-day expert workshop will be organized in each of the three regions to: 1) present and discuss where and how each of the validated technologies can be disseminated; 2) agree on models/pathways, partnerships and institutional arrangements for scaling out the SI technologies and practices; 3) identify capacity building needs and strategies to build the capacity of partners to scale out the technologies; and 4) how the beneficiary households can be monitored. Regional Training-of-Trainers workshops will be organized based on the identified training needs.

Partnership with the N2 Africa, and Cowpea and Groundnut Scaling projects to demonstrate and disseminate improved varieties and management practices on cowpea, groundnut and soybean will be strengthened to reach out to households beyond the Africa RISING project intervention communities.

Sub-activity GH4123-1704: Promote knowledge sharing for dissemination of technologies - Leader(s): Asamoah Larbi et al.

Several strategies will be used to promote knowledge sharing and dissemination among scaling actors. This will include: 1) establishment of knowledge sharing and learning alliances among scaling actors at the community and district levels; 2) the Community-based Technology Park approach initiated by the WA project in Ghana and adapted in Mali; 3) radio and TV discussions; 4) development of media materials, e.g. posters, leaflets and films; 5) promotion of interest groups for specific technology or practice, especially women's groups and youth associations; 6) linking and/or integrating with existing initiatives, e.g. the 'Grow-for-jobs Initiative' to promote the cereal (maize, sorghum and millet) and legume (cowpea and soybean) value chains and the School Feeding Program of the Ghana Government.

Sub-activity GH4123-1705: Defining recommendation domains for Africa RISING validated technologies - Leader(s): Asamoah Larbi et al.

The scale of implementation of the WA project varies with activity in each country. It ranges from the plot to farm/field scale or from household to the community level. Most of the activities are

implemented at the plot or field levels. Nevertheless, results and output from the activities can be extrapolated to larger scales and bigger recommendation domains using modeling, Geographical Information Systems (GIS) and Remote Sensing Technique. For example, preliminary GIS analysis showed that results from plot activities implemented at the Natodori intervention community in the Upper West Region can be applied to other West African countries with similar agro-ecology and socio-economic environment.

In Phase 2, Decision Support Systems will be used to match the agronomic (fertilizer application, crop densities, planting dates, crop combinations) and livestock related technologies and practices to soil and climatic conditions for sustainable intensification of the cropping and livestock production systems, and to address production variability and risk in northern Ghana. This sub-activity is partly in response to the recommendations of the USAID-commissioned external evaluation team in Phase 1. The activity will be undertaken in collaboration with the GIS and Remote Sensing Unit of the University of Ghana and the IITA GIS Unit.

5. Data to be collected and uploaded	Responsibility
5.1 Number of beneficiary households	IITA and scaling partners
5.2 Number of national and international scaling actors	IITA and scaling partners
5.3 Number of proven technologies	IITA and scaling partners
5.4 Number of interest groups and association	IITA and scaling partners

6. Milestones

Deliverables	Means of verification	End date
6.1 Revised list of intervention communities	Technology briefs	Jul. 2017
6.2 Updated list of beneficiary households	Project reports	Jul. 2017
6.3 At least 3 technology briefs	Project reports	Aug. 2017
6.4 Knowledge sharing alliance in 4-6 communities	Project reports	Nov. 2017
6.5 Report of scaling partners workshop	Project reports	Nov. 2017

7. Sustainable intensification indicators

7.1 Productivity	
7.2 Environmental	
7.3 Economic	
7.4 Social	Gender equity and equity for youth and marginalized groups at the household level
7.5 Human	Capacity to experiment at the farm and household level

8. How will scaling be achieved?

Scaling will be achieved through strategic partnership with development partners.

9. How are the activities in this protocol linked to those of others?

Activities in this protocol are linked to those on all the other protocols because it promotes partnerships for the implementation and dissemination of the research and development activities.

10. Budget (USD)[1]

Budget Line	
Personnel	15,000
Services	20,000
Supplies	20,000

Capital	0
Travel	15,000
Overhead	0
Total	70,000
[1]The budget for this protocol is not included in the consolidated budget in Table 2. Because, it is assumed that funds for this protocol will be allocated from the budget for dissemination which is different from research. Funds will be allocated by IITA to partners based on their responsibilities in each of the sub-activities.	

Consolidated budget

Activity protocol	Leader	IITA	ILRI	IWMI	CIAT	WorldVeg	WUR	MOFA	STEPPRI	UDS	CCAFS	FOSTERING	Total
Outcome 1: Productive, resilient and sustainable crop-livestock systems													
Integrated crop-livestock production	IITA	380[1]				30		10			10		430
Aflasafe development	IITA	30											
Water resources management	IWMI			70									70
Land and soil resources management	CIAT				50								50
Outcome 2: Improved nutrition, food safety, post-harvest handling and value addition													
Nutrition-sensitive agriculture	ILRI		105			10				20			135
Post-harvest management	IITA	170[2]											170
Outcome 3: Enabling policies and institution for equitable access to production assets and markets													
Farming systems	WUR						25						25
Policies, institutions and markets	STEPRRI								25			10	35
Outcome 4: Partnerships to endure delivery and uptake of sustainable innovations at scale													
Promote partnerships for scaling of innovations	IITA[3]												0
Sub-total		580	105	70	50	40	25	10	25	20	10	10	945
Grand total							945						

[1]Includes 20,000 USD for graduate training;
[2]Does not include the 25,500 USD which will be paid directly
[3]Estimated budget not included because it is assumed that protocol will be funded from funds allocated for dissemination.
[4]The budget is in USD (x1,000)

Mali

Partners and their responsibilities

Name	Acronym	Role/responsibility
Government Ministries & Entities		
Institute d'Economie Rurale	IER	Research on crops, livestock, natural resources management and nutrition. Capacity building to graduate students and national partners.
Regional Direction of Agriculture in Sikasso	DRA-Sikasso	Scaling out technologies, provision of secondary data on socio-economics
Academic/ National Research Institutions		
Wageningen University	WUR	Postgraduate training program. Reports on typologies and farm characterization.
Institut Polytechnique Rural-De Formation et de Recherche Appliquee Katibougou	IPR-IFRA	Undergraduate and postgraduate training program
Non-Governmental organizations & research institutions		
Association Malienne d'Eveil et de Development Durable	AMEDD	Community mobilization, assisting research activities and implementation of field trials in farmers' field. Facilitating multi-stakeholders interest group meetings. Hosting site coordinators. Capacity building to national partners. Leading implementation of scaling programs in phase II.
Centre d'Appui a l'Autopromotion pour le Development	CAAD	Scaling out groundnut technologies. Assisting implementation of animal health and fattening program by IER.
Fédération Nationale pour l'Agriculture Biologique et Équitable	FENABE	Community mobilization to facilitate implementation of field trials in farmers' field. Work with AMEDD on multi-stakeholders interest group meetings in Bougouni.
Le Group de Recherches d'Actions et d'Assistance pour le Développement Communautaire	GRAADCOM	Scaling out groundnut technologies. Assisting implementation of animal health and fattening program by IER.
International Crops Research Institute for the Semi-Arid Tropics	ICRISAT	Mali project management. Consolidation of work plans, technical and financial reports. Activity coordination. Research on crops, natural resources management, socio-economics and scaling strategies. Capacity building to graduate students and national partners.

International Food Policy Research Institute	IFPRI	Monitoring and evaluation. Guidance on preparation of work plans to fit into FtF and other custom indicators.
International Institute of Tropical Agriculture	IITA	Overall project management and scientific guidance. Approval of work plans, evaluation of approved work plans and timely fund release. Organization of regional scientific meetings and exchange visits.
International Livestock Research Institute	ILRI	Research on livestock and scaling out strategies. Capacity building to graduate students and national partners.
The World Vegetable Center	World Veg.	Research on vegetables, nutrition and scaling strategies. Capacity building to graduate students and national partners

Summary

The Africa RISING West Africa (WA) project is being implemented by multi-disciplinary research teams and development partners from the public and private sectors in collaboration with farmers and community-based organizations in northern Ghana and southern Mali.

This document presents the work plan for the 2017-2018 research year for Mali. The work plan is mapped under the four Outcomes in the Phase 2 project logframe (See Table 1 below). A total of twenty activity protocols are presented – 14 for Outcome 1; 1 for Outcomes 2; 3 for Outcome 3; and two for Outcome 4. The nutrition activities are integrated with the livestock and vegetable activities in protocol MA2111-17 under Outcome 2 in response to the recommendation of the USAID-commissioned external evaluation team.

Gender mainstreaming, capacity building and knowledge exchange and dissemination are embedded in all activity protocol. Linkages between activities are presented in each activity protocol. Publication of research results and better communication among research teams within and across countries will be a major focus.

Background

Phase 1 (1 October 2012 - 30 September 2016) of the USAID-funded Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) project in West Africa (WA) was implemented in 25 intervention communities in northern Ghana and 9 villages in the Bougouni and Koutiala districts of the Sikasso Region in southern Mali under the *title 'Sustainable Intensification of Key Farming Systems in the Guinea-Sudano-Sahelian Zone of West Africa'*. Research activities under Phase 1 were organized around 3 research outputs (ROs), namely: 1) Situation analysis and program-wide synthesis (RO1); 2) Integrated Systems Improvement (RO2) and 3) Scaling and Delivery (RO3). Capacity building and gender were cross-cutting.

Phase 2 (1 October 2016 to 30 September 2021) of the WA project was launched in February 2017. The work plan is organized around 21 activities under 11 outputs to achieve four outcomes (Table 1). Implementation will be guided by achievements and lessons from Phase 1. There will, however, be a shift in approach from Research-for-Development(R-4-D) in Phase 1, to Research-in-Development (R-in-D) in Phase 2.

Technological packages and/or practices validated in Phase 1 (see Table 2) will be scaled out targeting agro-ecosystems and socio-economic circumstances defined by the sustainable intensification (SI) domains - productive, economic, social, human and environmental. Linkages will be established with research and development partners to undertake both generic and back-stopping research. The generic research aims at completing the loose ends of research on the SI innovations in Phase 2 plus any other emerging issues; the emphasis of the back-stopping research will be to address researchable issues emerging from the scaling-out of SI innovations with the development partners.

Phase 2 will also explore new research areas emerging from Phase 1 experiences and feedback by research and development partners, notably, using results from farming systems analyses and farm types to inform research targeting and technology dissemination; post-harvest management and value addition; nutrition-sensitive agriculture; labor-saving

mechanization solutions for small-scale farmers; and climate-smart agriculture. The project will also develop the following research and development strategy documents: 1) a livestock strategy to increase the impact of livestock-related activities, especially those concerning small ruminants, poultry and pigs; and a nutrition strategy to harmonize nutrition-related activities with the crop and livestock activities, as well as with national nutrition approaches. It will engage in the purposeful inclusion of gender and youth concerns and develop more rigorous and quantitative approaches for measuring diffusion and early adoption of SI technologies.

Table 1: List of validated technologies ready for promotion through development partners in Bougouni and Koutiala districts

Broad category	Validated flagship technology
Introduction of new crops and varieties to overcome existing biotic and abiotic stresses and improve productivity per unit land area	High-performing and dry season-adapted and farmer preferred vegetable varieties of okra (Konni), African eggplant (L10), Tomato variety (Rio Grande) Aflatoxin resistant groundnut, early-maturing groundnut Sorghum hybrids (Pablo, Fadda and Sewa), dual-purpose sorghum (Soubatimi, Tiandougou Coura, Jiguikala and Peke)
Agronomic practices to improve grain and fodder yield per unit land area, and improve soil nitrogen	Cereal-vegetable intercropping (tomato, pepper) Cereal-legume intercropping (groundnut) Dual-purpose food legumes
Integrated S*triga* and soil fertility management as a cost-effective approach to replenish soil fertility	Fertilizer micro-dosing, composting Cereal-vegetable intercropping (tomato, pepper) Cereal-legume intercropping (groundnut)
Improved livestock feeds and feeding, housing, health and breeding management packages	Stover quality improvement using feed chopper
Introduction of improved land and water management systems	Contour bunding associated with fast-growing tree species
Seed treatment	Apron Star 42WS
Biological control of millet head miner	Parasitoid Wasps bags

Planned work

The planned activities are presented in protocols. Activities under each protocol are aimed at achieving the outputs under the four outcomes in the project logframe.

Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.

a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.1:	Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production.
c. Sub-activity MA1111-17:	**Profitability and gender analysis of vegetable mono-cropping and intercropping**

d. Research team

Name	Institution	Role
Felix Badolo	ICRISAT	Conduct economic analysis
Bekele Kotu	IITA	Contribute to economic analysis
Jean-Baptiste Tignegre	WorldVeg	Conduct on-farm trials
Birhanu Zemadim	ICRISAT	Activity coordination

e. Student(s)

Name	Institute	Degree	Start	End
1. (To be identified)	IPR/IFRA Katibougou	BSc	Jul. 2017	Feb. 2018

f. Location(s)	Bougouni and Koutiala
g. Start	April 2017
h. End	February 2018

1. Justification

The effect of intercropping on pests and diseases reduces the effort and inputs required for crop protection. Positive physiological interactions can sometimes be observed from the intercropping system. There may be a symbiotic cohabitation between the two crops where intercropping reduces soil erosion due to optimum coverage of the soil (Zougmouré et al., 2001[32]). We noticed a number of studies compared and contrasted biological parameters. However, the economic and gender analyses were missing. This study will integrate and analyze the economic and gender aspects of the identified climate-smart crop varieties and agronomic practices (intercropping and mono-cropping) demonstrated and promoted by the World Vegetable center in the same project in Mali. Intercropping vegetables was done with cereals (sorghum and maize). The study will focus on women who apply these agronomic practices in their own fields. A comparative analysis (men/women) will be carried out in terms of grain yields and cash income.

[32] Zougmoré, R., Kambou, N.F., Ouattara, K. and Guillobez, S. (2001). Sorghum-cowpea intercropping: an effective technique against runoff and soil erosion in the Sahel (Saria, Burkina Faso). Arid Soil Research and Rehabilitation. 14: 329-342.

2. Objectives		
2.1 Evaluate yields and cash income per hectare of the vegetable mono-cropping and intercropping considering gender.		
3. Research questions		
3.1 What is the profitability of vegetable mono-cropping and intercropping systems? 3.2 Are agronomic practices (intercropping and mono-cropping) profitable to the farmers?		
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.).		
4.1 The analysis will use a household survey involving households that participated in the project activities in the intervention villages. The households will be randomly selected. Their availability to participate in the survey will also be taken into account. We will plan to interview about 50 households in each district (60% women, not necessarily women headed) in Bougouni and Koutiala districts. There is a consent form in the questionnaire on the availability of the farmers to participate in the survey. Even if the farmers have applied the technology in their field, they are not obliged to participate in the survey.		
4.2 Cost and benefit method. The survey will involve farmers who apply intercropping vegetables-cereals and mono-cropping for the climate-smart crop varieties. The profitability analysis requires information about farmers' characteristics, production systems, input use and cost, sales and market prices.		
5. Data to be collected and uploaded		Responsibility/Institute
5.1 Data will be gathered on socio-demographic characteristics, cultivated areas, agricultural equipment, use of improved technologies promoted by Africa RISING (mono-cropping and intercropping technologies), yields and production, market prices, sales, input costs (compost, fertilizers, workforce, etc.), and other characteristics. Previously conducted surveys, for example by IFPRI, will be checked not to duplicate efforts. However, these surveys do not have all information required for the current analysis. For example, there is no information about climate-smart varieties of vegetables (tomato, okra, etc.).		ICRISAT/WorldVeg
6. Milestones		
Deliverables	Means of verification	Date
6.1 Data on cost-benefit	Database uploaded on Dataverse	Aug. 2017
6.1 Cost and benefit analysis report	Report uploaded on Africa RISING West Africa Wiki page	Jan. 2017
6.2 Scientific article prepared	Submission to TSI journal	Feb. 2018
7. Sustainable intensification indicators		
7.1 Productivity	Yields per hectare at farm level	
7.2 Environmental	Farmer ranking of technology impact on soil quality at household level	
7.3 Economic	Net income per hectare at farm level	
7.4 Social	Gender at household level	
7.5 Human		

8. How will scaling be achieved?
Informing farmers about the benefits of these vegetable technologies, create awareness among farmers about the use of these technologies, facilitating the availability of these technologies through linkages with seed companies, and an advantageous credit system for the purchase of inputs (seeds, mineral fertilizers, manure, etc.) to increase the adoption.
9. How are the activities in this protocol linked to those of others?
The work closely links with WorldVeg under protocol number MA2111-17.

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.1:	Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production.
c. Sub-activity MA1112-17:	**Development of crop simulation models using different fertility sources and climate model outputs to improve the productivity of sorghum.**

d. Research team:

Name	Institution	Role
Birhanu Zemadim	ICRISAT	Activity leader
Akinseye Folorunso	ICRISAT	Postdoctoral fellow
Oumar Samake	AMEDD	Community mobilization and multi-stakeholder interest group formation
Karamoko Traore	ICRISAT	Field trial implementation in Koutiala
Mahamadou Dicko	ICRISAT	Field trial implementation in Bougouni

e. Student(s)

Name	Institute	Degree	Start	End
2. BSc intern	IPR/IFRA Katibougu	BSc	Jul. 2017	Feb. 2018

f. Location(s)	Bamako, Koutiala and Bougouni
g. Start	April 2017
h. End	February 2018

1. Justification

Studies have shown that optimum productivity in crops may not be achieved without appropriate fertility management (Traoré, B., et al., 2014[33]; Akinseye F.M., et al, 2016[34]). In the Sudanian region of Mali where sorghum is an important crop, inorganic fertilizer use is limited due to high cost and

[33] Traoré, B., van Wijk, MT., Descheemaeker, K., Corbeels, M., Rufino, MC, and Giller, KE. (2014). Evaluation of climate adaptation options for Sudano-Sahelian cropping systems. *Field Crops Research*, 156, 63–75.

[34] Akinseye, FM., Agele, SO., Traore, PCS. Adam, M., & Whitbread, AM. (2016). Evaluation of the onset and length of growing season to define planting date- 'a case study for Mali (West Africa)'. *Theor. Appl. Climatol*, 124, 973. doi:10.1007/s00704-015-1460-8

non-availability, and limited soil moisture availability. However, with large available organic resources from livestock and poultry manure, the study will evaluate different fertilizer response scenarios which will combine both organic and inorganic sources. Our target is to increase productivity (grain and biomass) while the biomass production could further be used as a source of feed for the livestock and vice-versa. Furthermore, data collected from different agro-ecologies will be used to set up crop simulation models using APSIM and DSSAT in combination with climate model output of the Coupled Model Inter-comparison Project Phase 5 (CMIP5) to assess climate change impacts on sorghum yields and to evaluate fertility scenarios and varieties as adaptation options to climate change.

2. Objectives

2.1 To acquire a better understanding of physiological functioning and yield potential of sorghum varieties under different fertilizer management regimes (livestock manure and inorganic fertilizer) across different rainfall gradients and soil characterizations

2.2 To analyze changes in future rainfall patterns, maximum and minimum temperatures under increased emission scenarios and its implication on sorghum productivity

2.3 To better quantify, through using the validated crop simulation models (APSIM and DSSAT), the productivity of the sorghum varieties under current agricultural management practices to future climate change

3. Research questions

3.1 How to increase sorghum productivity through optimizing fertilizer treatments (in agreement with climate-smart practices) and choosing the right variety?

3.3 What is the sensitivity of the current sorghum yield to climate change using high-resolution climate Models (GCMs) outputs

3.4 What physiological and soil parameters are important to create a suitable crops system model

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)

4.1 The protocol will follow a Split-Plot Design with 4 replications. The treatments for the main plot are: the use of inorganic fertilizer (DAP), manure from ruminants, poultry manure and the combination of the manures and NPK. The fertilizer treatments will be as follows: (i) DAP 100 kg/ha; (ii) NPK/DAP micro-dose (3g/hill), (iii) Cow manure (100g/hill), (iv) Cow manure (50g/hill) + poultry manure (50g/hill), (v) NPK/DAP (3g/hill) + Cow manure (100g/hill), (vi) Poultry manure (50g/hill), (vii) Poultry manure (100g/hill), (viii) Poultry manure (150g/hill), (ix) Poultry manure (100g/hill) + NPK/DAP micro-dose (3g), and (x) Control. Fertilizer will be applied at sowing. The sub-plot varieties include (CSM63E, CSM335 and Fadda). The main plot contains 94 rows (70.5 m) x 11 m with a total area of 775.5 m^2, and the sub plot has 6 rows (4.5 m) x 3 x 5 m long with a total area of 67.5 m^2. Net plot (harvested area) = 2 row x 5 m long = 7.5 m^2, and Gross plot = 50 m x 70.5 = 3525 m^2.

5. Data to be collected and uploaded	Responsibility/Institute
5.1. Agronomic and soil data	ICRISAT
5.2 Economic data: the cost of seed, fertilizer, cow manure, poultry manure, and labor.	ICRISAT
5.3. Climate data: daily rainfall, temperatures, solar radiation and relative humidity	ICRISAT

6. Milestones		
Deliverables	Means of verification	Date
6.1 Best fertilizer management practices that will contribute to increased sorghum productivity	Report on on-station and field trial included in the interim and final report	Dec. 2017
6.2 Model outputs on fertilizer scenarios to future climatic condition	Adaptation and tailoring of the decision support tools and APSIM and DSSAT	Dec. 2017
6.3 A conference paper will be prepared	Presentation in international workshop	Jan. 2018
6.4 Paper on Improving grain sorghum productivity in water-limited environments under climate change peer-reviewed journal	Field Crops Research Journal (submission)	Jun. 2018

7. Sustainable intensification indicators	
7.1 Productivity	Kg biomass (yield, fodder)/ha/season, coefficient of variability, distribution, etc. Number of crops grown per year on a given plot (by crop), Plant population density (seeds/ha/season or seeds/ha/year) at plot level
7.2 Environmental	Soil fertility, NPK, pH, OM at plot level
7.3 Economic	
7.4 Social	Ranking of technologies, Rating of technologies/treatments locally will be determined through analytical and modeling approaches at plot level
7.5 Human	

8. How will scaling be achieved?
Scaling is achieved through identification of various agronomic packages that are suitable to improve the overall crop productivity. The use of modeling approach helps to identify the potential yield advantages of varieties over a long-term climate change
9. How are the activities in this protocol linked to those of others?
This activity is linked to the following sub-activities; MA1113-17, MA1114-17

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.1:	Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production.
c. Sub-activity MA1113-17:	**Improving efficiency of compost processing for soil fertility management under cereal cropping system.**

d. Research team

Name	Institution	Degree	Research interest	Role
Bouba Traore	ICRISAT	PhD	System agronomist	Post-doctoral fellow

Birhanu Zemadim	ICRISAT	PhD	Land and water management	Activity coordination
Ramadjita Tabo	ICRISAT	PhD	System Agronomist	Scientific supervision

e. Student(s)

Name	Institute	Degree	Start	End
1. PhD candidate to be identified	IPR/IFRA Katibougu	PhD	Jul. 2017	Mar. 2020
2. MSc candidate to be identified (Improve soil fertility management)	IPR/IFRA Katibougu	MSc	May 2017	Jan. 2018
3. Sery Coulibaly	IPR/IFRA Katibougu	BSc	May 2017	Jan. 2018

f. Location(s)	Koutiala
g. Start	March 2017
h. End	January 2018

1. Justification

In Mali, soil fertility management is characterized by the limited use of organic matter content and low mineral fertilizer application leading to low crop production. Currently, farmers rely on the use of manure and compost for soil fertility management. However, many technical problems remain with regard to the quality such as CN ratio, NPK content and pH. Furthermore composting methods mostly used in the study area are based on pits, which are labor consuming and take long to compost. With regard to the extensive farming system and free grazing feeding system, less organic matter becomes available from (agro) pastoralists whose own needs are increasing in response to the expanding cropping activities. Obviously, livestock stocking rates that would provide enough manure to fertilize all fields of the farm are not realistically attainable in the study area. This activity aims to test promising alternative for improving compost process efficiency for sustainable intensification under cereal cropping system in southern Mali. Cotton stem initially burned by farmers will be used as the source of diversification for composting and will be compared to sorghum.

2. Objectives: Improving compost process efficiency for soil fertility management under cereal cropping system in southern Mali

2.1 Analyze strategies and management practices for manure production in smallholder farming system

2.2 Improve the efficiency of the composting process for sustainable soil fertility management

2.3 Improve application efficiency under cereal intercropping system

3. Research questions

3.1 What are the main constraints for composting? How can we reduce composting period? How can cotton stem be used as a source of diversification for composting compared to sorghum or maize biomass? How can the composting method improve quality (NPK content, C/N, labor) and therefore improve soil fertility?

3.2 How can the application technique of organic fertilizer improve crop production and soil fertility? How to improve manure application efficiency?

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.).

4.1 We will first analyze existing farming system and nutrient management data from Africa RISING Phase I. Extra data needed will be collected through a survey to use Nutrient Monitoring as a decision-support model.

4.2 To reduce labor, our approach will be based on compost heaps instead of compost pits. Five composting methods will be compared with the stems of cotton and sorghum. The stems of both crops will be cut into pieces of 10 to 20 cm arranged under successive layer which will receive different activators (inoculum, urea, cattle manure and PNT) and will be irrigated with water. Each compost heap will be covered with a plastic bag to limit evaporation and accelerate decomposition. In different composting methods below, the rates of input are in ha and will be adapted to the plots sizes.

Composting with cotton stem	Composting with sorghum stem
Compost 1: 1 ton cotton stem +1 kg inoculum	Compost 1: 1 ton sorghum stem +1 kg inoculum
Compost 2: 1 ton cotton stem + 25 kg ha^{-1} urea	Compost 2: 1 ton sorghum stem + 25 kg ha^{-1}urea
Compost 3: 1 ton cotton stem + 100 kg ha^{-1}cattle manure	Compost 3: 1 ton sorghum stem + 100 kg ha^{-1} cattle manure
Compost 4: 1 ton cotton stem + 25 kg ha^{-1}PNT (rock phosphate)	Compost 4: 1 ton sorghum stem + 25 kg ha^{-1} of PNT
Compost 5: 1 ton cotton stem + 25 kg ha^{-1} urea +1 kg ha^{-1} inoculum + 25kg ha^{-1}PNT (rock phosphate)	Compost 5: 1 ton sorghum stem + 25 kg ha^{-1} urea+1 kg/ha inoculum + 25 kg ha^{-1} PNT (rock phosphate)

Inoculum contains microbial isolates, enzymes and composting activation factors. It is highly effective for accelerating agricultural related composting.

4.3: The experimental design will be Fisher Block with 4 replications with maize as a test crop. Composts produced under activity 4.2 will be used for following treatments in order to evaluate impact on crop production and soil fertility

1: Control practice (0 Compost + recommended mineral fertilizer)
2: Farmer practice of spreading manure + Recommended mineral fertilizer
3: Localized application of compost 1+ Recommended mineral fertilizer
4: Localized application of compost 2+ Recommended mineral fertilizer
5: Localized application of compost 3+ Recommended mineral fertilizer
6: Localized application of compost 4 + Recommended mineral fertilizer
7: Localized application of compost 5+ Recommended mineral fertilizer
Recommended mineral fertilizer for maize is: 85 kg of N ha-1, 26 kg of P ha-1 and 16 kg of K ha-1)

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Existing farm data (cropping systems, livestock systems, biomass production and management, management strategies for organic and mineral fertilizers) from AR phase 1	ICRISAT
5.2 Data for Nutrient Monitoring Model	ICRISAT
5.3 Temperatures of the compost heaps and water for irrigation will be recorded each day during the first 10 days and then every week until the end of the composting process.	ICRISAT
5.4 For chemical characterization: PH (1: 2.5 H2O), organic carbon, total NPK, calcium, magnesium, C/N ratio will be determined in the laboratory as well as the maturation time of the compost.	ICRISAT

6. Milestones		
Deliverables	Means of verification	Date
6.1 Constraints and opportunities for organic fertilizer production are identified.	Report, MSc thesis. Uploaded on Africa RISING West Africa Wiki page	Jan. 2018
6.2 Promising composting technology is developed	Report, MSc thesis, Technical sheet; manual on composting. Uploaded on Africa RISING West Africa Wiki page	Jan. 2018
6.3 Efficiency of application technique of compost is demonstrated	Report, MSc thesis. Manual on the application of compost. Uploaded on Africa RISING West Africa Wiki page	Jan. 2018

7. Sustainable intensification indicators	
7.1 Productivity	Yield, Biomass, Farmer perceptions, Agricultural survey at plot level
7.2 Environmental	Soil fertility, NPK, pH, OM at plot level
7.3 Economic	Profitability, diversification of technology at household level
7.4 Social	Ranking of technologies, Farmer perceptions, Access to production factors, Decision-making about technologies at household level
7.5 Human	Food production (Calories/ha), Number of new practices being tested at household level

8. How will scaling be achieved?
Developed technologies will be scaling up through training farmers in different villages and developing technical sheets for extension workers.
9. How are the activities in this protocol linked to those of others?
Since this activity is based on strengthening soil fertility, results can be used by other activities in relation to soil.

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.1:	Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production.
c. Sub-activity MA1114-17:	**Cost-benefit analysis of fertilizer treatments for sorghum production.**

d. Research team

Name	Institution	Role
Felix Badolo	ICRISAT	Conduct economic analysis
Bekele Kotu	IITA	Contribute to economic analysis
Baloua Nebie	ICRISAT	Conduct field experimentations
Birhanu Zemadim	ICRISAT	Activity coordination

e. Student(s)				
Name	Institute	Degree	Start	End
1. To be identified	IPR/IFRA Katibougu	MSc	Jul. 2017	Jan. 2018

f. Location(s)	Bougouni and Koutiala
g. Start	March 2017
h. End	September 2017

1. Justification
A number of fertilizer treatments are being identified from a biological production perspective (e.g. fertilizer treatments for the sorghum production without economic indicators). However, socio-economic information about these technologies is lacking. The study aims to evaluate these fertilizer treatments from the socio-economic point of view. The study was carried out in 2016 with two periods of data. To have reliable data analysis and publication, three years of data are required. We continue the study by integrating the data collected in 2016 (household survey data).
2. Objectives
2.1 – Conducting comparison/contrasting use of fertilizer treatments with respect to economic advantages and production risks
2.2 – Given that most farmers in West Africa are concerned about cash income derived from farm product sale, this study evaluates the net returns and income risk efficiency associated to cropping treatments
3. Research questions
3.1 Which fertilizer treatment options are economically viable for farmers?
3.2 Which fertilizer treatment option is best in terms of both financial and production risk reduction?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.).
4.1 The analysis will use a household survey involving the households that participated in the project activities in the intervention villages. This is the second part of the survey, and it will mainly concern households that participated in the first phase. The households were randomly selected. We plan to interview about 50 households in each Bougouni and Koutiala districts.
4.2 Cost and benefit analysis The study will use the stochastic dominance method because it uses simple, intuitive observations on farmer behavior, and do not impose restrictions on the decision maker's utility function (Hien V., et al., 1997[35]). This method applies the first two stochastic dominance rules based on cumulative distribution analysis of grain yields and net returns from different fertilizer treatments. Input costs included seeds, manure, and fertilizer, labor and harvesting. The net returns are derived from cost and benefit analysis of fertilizer treatments. The Kolmogorov-Smirnov test is used to determine if two distribution functions are significantly different.
4.3 Stochastic dominance analysis

5. Data to be collected and uploaded	Responsibility/Institute
Data will be gathered on socio-demographic characteristics, cultivated areas, agricultural equipment, use of improved technologies promoted by Africa RISING (mainly sorghum technologies), yields and production,	ICRISAT

[35] Hien, V., Kabore, D., Sansan, Y. and Lowenberg-DeBoer, J., 1997. Stochastic dominance analysis of on-farm-trial data: The riskiness of alternative phosphate sources in Burkina Faso. Agricultural Economics 15 (1997) 213-221

market prices, sales, input costs (compost, fertilizers, workforce, etc.), and other characteristics	

6. Milestones		
Deliverables	Means of verification	Date
6.1 Data collection	Database available and uploaded on Dataverse	Aug. 2017
6.1 Cost and benefit analysis report concerning the alternative systems for sorghum production	Report uploaded on Africa RISING West Africa Wiki page	Sep. 2017
6.2 Peer-reviewed paper on economic analysis of alternative systems for sorghum production	Paper submitted to journal	Dec. 2017

7. Sustainable intensification indicators	
7.1 Productivity	Yields per hectare at farm and household level
7.2 Environmental	
7.3 Economic	Net income per hectare at farm and household level
7.4 Social	
7.5 Human	

8. How will scaling be achieved?
Scaling will be done by highlighting benefits regarding the application of fertilization options for the sorghum production, by creating awareness among farmers about the use of these technologies and facilitate the adoption of these technologies through development strategies of inputs market particularly manure and mineral fertilizers in order to make them available for the smallholder farmers.
9. How are the activities in this protocol linked to those of others?
Activity has links with that of promoting high-yielding hybrids and dual/multi-purpose sorghum under protocol number MA1115-17.

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.1:	Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production.
c. Sub-activity MA1115-17:	**Promoting high-yielding hybrids and dual/multi-purpose sorghum for crop-livestock integration and income generation in Sikasso Region.**
d. Research team	

Name	Institution	Role
Baloua Nebie	ICRISAT	Coordination of activities
Aboubacar Toure	ICRISAT	Head of sorghum program/scientific support

Mamourou Sidibe	ICRISAT	Supervision of activities
Abdoulaye Diallo	IER	Supervision of activities

e. Student(s)

Name	Institute	Degree	Start	End
Kaba Badjiri Diakite	IPR/IFRA Katibougu	MSc	Jul. 2017	Mar. 2018
Abdoulaye Keita	IPR/IFRA Katibougu	Technician	Jul. 2017	Mar. 2018

f. Location(s)	Koutiala and Bougouni districts (97 farmers, 9 villages with 18 farmers per village in Bougouni and 5 farmers per village in Koutiala)
g. Start	April 2017
h. End	February 2018

1. Justification

In Mali, sorghum and millet are used by farmers as staple food, especially in the rural areas. With the continual increase of livestock coupled with the diminishing natural pastures, crop residues are playing an important role in animal feeding. Farmers are using landrace residues as fodder but the quantity and especially the quality of this feed is limited/poor. The stems are tall and hard due to high lignin content which negatively influences fodder digestibility. Also, most of the improved Open Pollinated Varieties (OPVs) have low grain yield advantages compared to the local varieties. New varieties of sorghum combining grain yield (2t/ha), fodder yield (15 to 20 t/ha for fresh stover) and quality (green leaves until grain maturity) are now available. In addition to these varieties, hybrids with 30% yield advantage compared to the local variety were developed and tested in Mali (Rattunde et al., 2013[36]; Kante M. et al., 2017[37]; CEDEAO, L'UEMOA, Le CILSS, 2016 [38].

These varieties and hybrids were tested during phase one of Africa RISING program in different agro-ecologies and seed production is organized with farmers' cooperatives. Therefore, this activity was proposed for promoting these technologies through four technology parks, farmers' fields and through linking farmers to seed cooperatives where they are available. With these varieties, farmers could double gains and also increase their productivity and income. The proposed activity consists of a research and scaling component: The research component involves comparing improved varieties (hybrids and multipurpose varieties) to the local ones under different agronomic practices such as fertilizer type use (chemical vs. organic manure). And the scaling component involves scaling up of varieties which were already tested in the target zones and officially registered into the national catalogue during the end of Africa RISING phase 1 period.

2. Objectives

2.1 Diversify sorghum varieties grown by farmers by introducing improved varieties

2.2 Enhance farmers productivity through use of high yielding hybrids of sorghum

2.3 Identify best variety and agronomic practice (s) for intensifying grain and fodder production under farmers' field conditions

[36] Rattunde, H.F.W., E. Weltzien, B. Diallo, A.G. Diallo, M. Sidibe, A.O. Touré et al. 2013. Yield of photoperiod-sensitive sorghum hybrids based on guinea-race germplasm under farmers' field conditions in Mali. Crop Sci. 53:2454–2461. doi:10.2135/cropsci2013.03.0182

[37] Kante M., H.F.W. Rattunde, W.L. Leiser, B. Diallo, A. Diallo, A. Touré, B. Nebié, E. Weltzien, B.I.G. Haussmann. 2017. Can tall Guinea-race sorghum hybrids deliver yield advantages to smallholder farmers in West and Central Africa? Crop Science, 57:1–10

[38] CEDEAO, L'UEMOA, Le CILSS, 2016. Catalogue Régional des Espèces et Variétés Végétales. http://www.insah.org/doc/pdf/Catalogue_Regional_semences_vf_janv_2017.pdf

3. Research questions
3.1 What are the best dual-purpose varieties and hybrids preferred by f farmers and adapted to their conditions?
3.2 What is the best combination of variety and agronomic practice for better integration of crop and livestock?
3.3 What option (variety x agronomic practice) is the most appropriate for farmers and in what condition?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) Three sorghum hybrids and three dual-purpose sorghum varieties will be evaluated with 97 farmers from 9 villages (Bougouni and Koutiala circle). From each village of Koutiala, 5 farmers will be selected while in Bougouni, 18 farmers per village will be selected. To enable comparison between the improved variety and the local one in the target zone, farmers preferred variety will be included as local check in the trials. Two types of fertilizers (organic manure = 5 tons/ha and DAP = 100 kg/ha) will be compared to farmers traditional practice (no fertilizer).
4.1 Identification and training of farmers for the demonstration plots implementation. A set of men and women will be trained to be farmers trainers in each locality.
4.2 Evaluation of variety and hybrids by farmers (men and women) in their fields with farmers' practices and improved practices (plants density and fertilizer application). A total of 97 farmers from 9 villages (Bougouni and Koutiala zones) will conduct these trials.
4.3 Data collection and analysis

5. Data to be collected and uploaded	Responsibility/Institute
5.1 List of farmers implementing the activity and their diversity	Mamourou Sidibe/ICRISAT
5.2 Field characterization (soil type, cropping system, etc.)	Mamourou Sidibe
5.3 Farmers preferences for varieties	Baloua Nebie/ICRISAT & A Diallo/IER
5.4 Feedbacks of farmers during field days	Baloua Nebie /ICRISAT
5.5 Grain yield	Baloua Nebie /ICRISAT
5.6 Stover yield	Baloua Nebie /ICRISAT
5.7 Plot survey (yields and input costs)	Felix Badolo/ICRISAT

6. Milestones		
Deliverables	Means of verification	Date
6.1 Agronomic data	Database uploaded to Dataverse	Feb. 2018
6.2 Farmer trainings/ workshops / field days	Report uploaded on Africa RISING West Africa Wiki page	Feb. 2018
6.3 Promotional documents of varieties based on farmers' feedback	Briefs uploaded on Africa RISING West Africa Wiki page	Feb. 2018
6.4 Scientific publication (with 2 years data)	Article submitted to TSI journal	December 2019

7. Sustainable intensification indicators	
7.1 Productivity	Yield/ha at plot and farm level
7.2 Environmental	
7.3 Economic	Net income/ha at plot and farm level
7.4 Social	
7.5 Human	

8. How will scaling be achieved?
Farmers will be exposed to improved dual-purpose sorghum and sorghum hybrids with different agronomic practices in their conditions which allows them comparing the new technologies to their own ones. Most of the fields will be near the road or public places and plots will be labeled with key information to reach an important number of farmers. The same technologies will be implemented in the technology parks at Bougouni and Koutiala districts. Among the testers, we have a farmers' association that produces milk in Koutiala district for selling. Some farmers of this association started, in 2015, using improved sorghum varieties stover for livestock feeding. The number of farmers using improved dual-purpose sorghum will be increased. Farmers from each village will be invited for field visits and the agricultural extension services in the different zones, rural radios will be also engaged in large-scale communication. Farmers Seed cooperatives are involved in the implementation of the activities so that they can produce seed for themselves and for others farmers who will look for a given variety.
9. How are the activities in this protocol linked to those of others?
This activity is focused on yield-increasing (hybrids) and especially on crop-livestock integration (dual-purpose sorghum). It is therefore linked to activities on "Test and disseminate techniques for upgrading poor forages to enhance livestock feeding during the dry season, MA1122-17, "Feed-health interventions for improved small ruminant production, MA1121-17", "Sheep fattening to reduce poverty and food insecurity for women farmers, MA1123-17" The economic analysis under activity "MA1114-17 Cost-benefit analysis of fertilizer treatments for sorghum production" is a sub-activity of this one as all information will be taken from the trials.

8. Budget (US$)				
Outcome/Output/Activity	Sub-activity	Budget Line	ICRISAT	AMEDD
Outcome 1/Output 1/Activity 1	MA1111-17	Personnel	1,000	2,000
		Services	2,500	500
		Supplies	5,500	4,500
		Capital		
		Travel	1,000	3,000
		Overhead	1,500	1,500
		Total	11,500	11,500
Outcome 1/Output 1/Activity 1	MA1112-17	Personnel	1,000	6,000
		Services	2,500	6,500
		Supplies	10,500	500
		Capital		
		Travel	1,000	7,000
		Overhead	2,250	3,000
		Total	17,250	23,000
Outcome 1/Output 1/Activity 1	MA1113-17	Personnel	1,000	
		Services	3,000	
		Supplies	14,500	
		Capital		
		Travel	1,500	

		Overhead	3,000	
		Total	23,000	
Outcome 1/Output 1/Activity 1	MA1114-17	Personnel	1,000	
		Services	1,500	
		Supplies	5,000	
		Capital		
		Travel	2,500	
		Overhead	1,500	
		Total	11,500	
Outcome 1/Output 1/Activity 1	MA1115-17	Personnel	1,000	
		Services	1,500	
		Supplies	4,500	
		Capital		
		Travel	3,000	
		Overhead	1,500	
		Subtotal	11,500	
		Total	74,750	34,500
		Grand Total	109,250	

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.2:	Test and disseminate a combination of improved breeds, housing, feeding, health and breeding practices to intensify rearing of livestock (sheep, goat, pig, and poultry) for meat, egg and milk production.
c. Sub-activity MA1121-17:	**Feed-health interventions for improved small ruminant production.**

d. Research team

Name	Institution	Role
Augustine Ayantunde	ILRI	Sub-activity leader (design, data analysis and reporting)
Siaka Coulibaly	AMEDD	Monitoring
Seydou Koita	AMEDD	Monitoring and data collection
Hamidou Nantume	IER	Collaboration
Karamoko Traore	ICRISAT	Koutiala site coordinator

e. Student(s)

Name	Institute	Degree	Start	End
1.				

f. Location(s)	Sirakele and Zanzoni villages (Koutiala)
g. Start	April 2017
h. End	February 2018

1. Justification	
It has been demonstrated that simple interventions such as health interventions, supplementary feeding and good housing have significant positive effect on performance and productivity of small ruminants. Building on results of feed-health interventions for improved small ruminant production in Africa RISING intervention communities in Mali, this study is designed to improve sheep and goat production in two intervention communities in Koutiala. This is a pilot study in Sirakele and Zanzoni which started in August 2016. There are 2 treatments – control (farmers' practice) and feed-health intervention. The health treatment includes vaccination against PPR and pasteurellosis, deworming and antibiotic treatment along with supplementary feeding. This pilot study in Mali is done based on the experience in Ghana from feed-health interventions. The study was proposed for Mali to strengthen the livestock activities which up till now have focused on natural resource management. Even though the same study was conducted in Ghana under Africa RISING phase I, the results for Mali may be different as feed resources are different. For example, the supplement used in Mali is cotton seed cake which is commonly available whereas in Ghana we prepared a mixed ration as supplement. The other issue concerning this study was that it was recommended based on the report of the evaluation team that livestock component was weak. So the study was suggested for Mali by the chief scientist based on the experience in Ghana. This study is on-farm and being managed by farmers which provides a good platform for learning by the farmers. Farmers learn better by doing than just seeing the demonstration. In addition, the capacity of the farmers is enhanced through training in improved small ruminant production.	
2. Objectives	
2.1 To test the feed-health intervention for improved small ruminant production in Koutiala and to assess benefit and cost.	
3. Research questions	
3.1 What are the effects of feed and health interventions on small ruminant performance? What are the costs and benefits of these interventions?	
3.2 How do improved small ruminant production practices impact on the livelihoods of the smallholder crop-livestock farmers?	
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)	
4.1 Twenty farmers are selected in each community, and their sheep and goats are being monitored. The feed-health intervention is applied to twenty farmers in Sirakele village while twenty farmers in Zanzoni village serve as control group. The farmers selected have at least 6 sheep and goats. A livestock technician is responsible for the data collection on monthly weight changes, manure production and flock dynamic (birth, death, purchase, sale, animal given as a gift, animal consumed etc.). The cost-benefit analysis will be conducted to assess the profitability of the feed-health intervention. The management practices of the selected households will be documented by sex. The State Veterinary services will be responsible for the application of the health intervention including vaccination of the sheep and goats in Sirakele. The experimental farmers in the study will be trained in improved small ruminant production practices.	
5. Data to be collected and uploaded	Responsibility/Institute
5.1 Weight data of experimental animals in Sirakele and Zanzoni villages	Augustine Ayantunde/ILRI

5.2. All data collected under 4.1	Augustine Ayantunde/ILRI

6. Milestones		
Deliverables	Means of verification	Date
6.1 Report of the study including cost-benefit analysis	Report uploaded on Africa RISING West Africa Wiki page	Feb. 2018
6.2 Weight development data and all the other data collected under 4.1	Data uploaded on Dataverse	Apr. 2018
6.3 Recommendations for farmers on improved small ruminant production practices	Report uploaded on Africa RISING West Africa Wiki page	Feb. 2018
6.4 Farmers trained in improved small ruminant production practices	Report of training uploaded on Africa RISING West Africa Wiki page	Apr. 2018

7. Sustainable intensification indicators	
7.1 Productivity	Average daily gain of experimental animals at plot level
7.2 Environmental	Quality of animal manure at plot level
7.3 Economic	Cost-benefit of feed-health intervention at household level
7.4 Social	
7.5 Human	

8. How will scaling be achieved?
This pilot study in two Africa RISING communities will be scaled up through AMEDD to the other Africa RISING communities through exchange visits, demonstrations and training in improved small ruminant husbandry. In addition, the integrated package being piloted will be taken to scale by USAID Mali Livestock Technology Scaling Program in their intervention communities in Mali.
9. How are the activities in this protocol linked to those of others?
The proposed activity is linked to the Activity 1 under Outcome 2 on nutrition-sensitive agricultural interventions as an integrated package. Feed and health interventions from this study will be added to the livestock interventions package for improved household nutrition.

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.2:	Test and disseminate a combination of improved breeds, housing, feeding, health and breeding practices to intensify rearing of livestock (sheep, goat, pig, and poultry) for meat, egg and milk production.

c. Sub-activity MA1122-17:	Test and disseminate techniques for upgrading poor forages to enhance livestock feeding during the dry season.

d. Research team

Name	Institution	Role
Hamidou Nantoumé	IER	Leader of the sub activity
Augustine Ayantunde	ILRI	Contributing to research protocols
Gaoussu Diawara	CAAD	Field implementation
Fousseni Dembele	GRAADCOM	Field implementation
Toumaini Sidibe	FENABE	Field implementation and data collection
Karamoko Traore	ICRISAT	Koutiala site coordinator
Dicko Mahamadou	ICRISAT	Bougouni site coordinator

e. Student(s)

Name	Institute	Degree	Start	End
MSc student to be identified	IPR/IFRA Katibougu	MSC	Jul. 2017	Feb. 2018

f. Location(s)	Bougouni
g. Start	May 2017
h. End	December 2017

1. Justification

The ability of small ruminants to grow, develop, reproduce and produce meat and milk is influenced by how much they get to eat and the quality of what they eat. If they don't get adequate nutrition, all these functions slow down or cease. Providing adequate feed for animals the year round can be a problem in Mali. There is plenty of good natural feed during the rainy season when quality and quantity of forages are best, but not enough feed during the period of the dry season characterized by a scarcity and lower quality of feed. Natural grazing lands are the main feed source of ruminants. Quality and availability know tremendous variations between seasons and years. The result is that the animals experience weight gains during the rainy seasons and weight losses during the dry seasons (Nantoumé, H., et al., 2011[39]). Weight losses of up to 15 to 20% were reported (Wilson, R.T., 1988[40]). High mortality and reduced performance in milk production and reproduction occur during the dry season as well.

To provide the extra and appropriate feed needed to cover the animal demands during the dry season several techniques can be used. The most important are silage making, haymaking, chopping (physical treatment) and urea treatment of forages. Most of these technologies are not new but their adoption rates appear to be relatively low.

2. Objectives

To disseminate forage upgrading technologies for optimum and efficient utilization of poor forages to enhance livestock feeding during the dry season through training and demonstration. The specific objectives are to master the techniques of:

2.1. How to make a good silage

2.2. How to make a good hay

[39] Nantoumé, H., A. Kouriba, C.H.T. Diarra et D. Coulibaly. 2011. Amélioration de la productivité des petits ruminants : Moyen de diversification des revenus et de lutte contre l'insécurité alimentaire. *Livestock Research for Rural Development* 23 (5) 2011. http://www.lrrd.org/lrrd23/5/nant23110.htm

[40] Wilson, R.T. 1988. La production animale au Mali Central: Etudes à long terme sur les bovins et les petits Ruminants dans le système agro-pastoral. Rapport de recherche no 14, CIPEA, 116p.

2.3. How to do physical treatment of forage using choppers
2.4. How to do chemical treatment of forage using urea
3. Research questions
3.1. Are farmers aware of the techniques of making good silage, good hay and physical and chemical treatments that will enhance livestock feeding during the dry season?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1. First of all, Africa RISING phase I report will be assessed to know more about feed availability and quality and the related problems of feeding livestock during the dry season. A survey will be conducted to complement the data gaps if any. This will help in determining how and where the problem is the most important. Then, training and demonstration on how to upgrade poor forages will be conducted to farmers for enhancing livestock feeding during the dry season. The poor forages of interest are the plants and residues of the most cultivated cereals (maize and sorghum), and, a natural grass (*Pennisetum pedicellatum*). Two main processes will be used to 1) preserve the excess forage of the rainy season when its quality and quantity is best through silage making and haymaking and to 2) treat the dry forage through chopping (physical treatment) or urea treatment (chemical treatment). Therefore, silage making, haymaking, chopping and urea treatment are the technologies that will be applied to the three poor forages. Training and demonstration of the technologies will be provided to farmers organized as IP (innovation platform) around the subject The manual "Upgrading poor forage to enhance livestock feeding during the dry season" using the IAR4D (integrated agricultural research for development) principles will be used to train the farmers in the four technologies. The Technology parks that are a suitable means for technology validation, awareness creation, farmer capacity building are also used as important meeting points. Therefore, they will be the ideal places for farmer field days and where the technologies (silage making, haymaking, chopping and urea treatment) will be demonstrated. To do so, availability of plant materials on which the technologies will be applied, harvesting tools, chopping machines, storage structure (silo), etc., at the technologies parks is necessary. Two villages in Bougouni where the parks have been established (Flola and Madina) will be involved in the demonstration and experimentation with a total sample size 40 (50 % women).
4.2. *P. pedicellatum*, one of the most common natural grasses, will be used to make silage. The plant will be cut in late August or early September at the stage of heading flower, chopped and ensiled using a square silo of $1m^3$ (1 m of height and 1 m of sides) built in the two technology parks of Bougouni. All the steps of a good silage making (weighing, cutting, wilting if necessary, chopping and storing) will be conducted with the participation of the 40 collaborating farmers. The silo will be opened during the dry season and used to feed sheep as needed. Silage samples will be taken from each silo for lab analyses.
4.3. In late September or early October, the natural grass *P. pedicellatum* will be cut just before flowering for making good hay. To do so, all the recommendations of producing quality hay, weighing, storage and handling and, use of harvesting tools will be applied. Samples of the hay will be compared with the standing *P. pedicellatum* hay using lab analyses.
4.4. After harvesting, residues of maize and sorghum will be collected and stored for later use. In March, the two crop residues and the collected natural grass (*P. pedicellatum*) will be weighed, chopped using two different types of choppers in each area of study. The characteristics of the 2 types of choppers will be compared. Samples of the chopped grass will be taken for lab analyses.

4.5. All the three chopped forages could be treated with urea but to reduce the cost, only maize stover and bush hay (*P. pedicellatum*) will be treated with urea at 5% on DM basis for feeding sheep later on (April). Samples taken from the treated and untreated forages (maize and *P. pedicellatum*) will be analyzed for chemical composition.	
4.6. All the feed samples (green plants, silages, hay, non-treated crop residues, urea treated residues) in each of the technology parks, will be analyzed for dry matter, crude protein, ash, crude fat, crude fiber, gross energy, calcium and phosphorus at the animal nutrition lab using one of the parks as duplicate in each area.	
4.7. Statistical analyses will be performed on the collected data using appropriate experimental design. Performances of the 2 types of choppers will be compared using the prices of the equipment, energy source, power, maintenance requirements, output, fuel consumption, etc., and the quality of the outputs of the 3 types of forages. The chemical composition of the 3 silages, 3 green forages, 3 untreated dry forages and 3 urea treated forages will be compared.	
5. Data to be collected and uploaded	Responsibility/Institute
5.1. Quantity (kg) and quality (lab analyses) of silage made	IER
5.2. Quantity (kg) and quality (lab analyses) of hay made	IER
5.3. Quantity (kg), quality (lab analyses) of chopped forages (green and dry) and urea treated forages	IER
5.4. Efficiency of the types of choppers	IER/ICRISAT
5.5 Farmers' preferences for a specific chopper	

6. Milestones:

Diagnosis on farmer training/demonstration needs to be done in June/July; Farmers are trained and benefited to demonstration on: silage making in August-September haymaking in September- October, chopping and urea treatment in July

Deliverables	Means of verification	Date
6.1. Results of the diagnostic on training needs	Report uploaded on Africa RISING West Africa Wiki page, field visits	Aug. 2017
6.2. Trainings and demonstrations on silage making	Report uploaded on Africa RISING West Africa Wiki page, field visits	Jan. 2018
6.3. Trainings and demonstrations on haymaking	Report uploaded on Africa RISING West Africa Wiki page, field visits	Jan. 2018
6.4. Trainings and demonstrations on chopping	Report uploaded on Africa RISING West Africa Wiki page, field visits	Jan. 2018
6.5. Trainings and demonstrations on urea treatment	Report uploaded on Africa RISING West Africa Wiki page, field visits	Jan. 2018

7. Sustainable intensification indicators

7.1 Productivity	kg and quality silage produced/crop; kg and quality of hay produced; kg and quality of forage chopped/ crop; kg and quality of urea treated forage at farm level
7.2 Environmental	
7.3 Economic	Output value – input costs; net returns per unit labor input at farm level

7.4 Social	Collective action at household level
7.5 Human	Capacity to experiment at household level

8. How will scaling be achieved?
At least two farmers from each participating village in Bougouni district will learn the four technologies (silage making, hay making, chopping and urea treatment) through trainings and demonstrations at the technology parks using the principles of IAR4D. Interactions between stakeholders will encourage peer learning. A local NGO named FENABE will be trained to upscale the technologies in other villages.
9. How are the activities in this protocol linked to those of others?
These activities are directly related to the activities of "Sheep fattening". The activities of this protocol are linked to those on "Feed-health interventions for improved small ruminant production" MA1121-17, "Sheep fattening to reduce poverty and food insecurity for women farmers" MA1123-17 and "Evaluation of nutrition-sensitive agriculture options in Mali". They all deal with how to improve small ruminant productivity MA2211-17.

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.2:	Test and disseminate a combination of improved breeds, housing, feeding, health and breeding practices to intensify rearing of livestock (sheep, goat, pig, and poultry) for meat, egg and milk production.
c. Sub-activity MA1123-17:	**Sheep fattening to reduce poverty and food insecurity for women farmers.**

d. Research team

Name	Institution	Role
Hamidou Nantoume	IER	Leader of the sub activity
Augustine Ayantunde	ILRI	Contributing to research protocols
Felix Badolo	ICRISAT	Economic analysis
Ousmane Sanogo	IER	Field implementation
Toumaini Sidibe	FENABE	Field implementation and data collection
Karamoko Traore	ICRISAT	Koutiala site coordinator
Dicko Mahamadou	ICRISAT	Bougouni site coordinator

e. Student(s)

Name	Institute	Degree	Start	End
PhD candidate to be identified	IPR-IFRA Katibougou	PhD	Jul. 2017	Dec. 2020

f. Location(s)	Bougouni and Koutiala
g. Start	March 2017
h. End	December 2017

1. Justification
In Mali livestock are estimated to 10,622,750 cattle, 15,143,415 sheep and 21,087,300 goats (DNPIA, 2016)[41] which contribute to 17% of the gross national product. Livestock plays an important role in social activities and in the supply of animal products (meat and milk). Moreover, sheep and goats provide an additional income source to low-capital family farms. The yearly meat consumption per inhabitant that is estimated at 12kg was supposed to increase to 21kg in 1991 according to the five years plan of 1987-1991. Food insecurity that results is shown not only as food deficit but as a non-balanced nutrition in food requirements in most of the urban and rural populations of Mali. Sheep fattening is becoming very common and practised without any gender restriction both in the large and small villages, especially during the religious feasts period. The rations fed, the length of the fattening period, the age and breeds used and other techniques (vaccination, deworming) makes the profits gained very diverse. In Mali, several studies have been conducted on small ruminants' fattening in both on-farm conditions (Kolff and Wilson, 1983[42]; Tangara, T., 1989 [43]; Nantoumé, H., et al., 2016[44]) and on station studies (Ballo, A.H., et al., 2004[45]; Doumbia, M., 1974 [46]). Average daily gains of 50 to 200 g and net profit from 11,000 to 33,300 FCFA were obtained depending on the fattening conditions and the breeds used.
2. Objectives
The general objective of this study is to improve the production of good quality sheep meat and the producers' income that will contribute to reducing poverty and food insecurity. The specific objectives are:
2.1. To improve the production of good quality sheep meat
2.2. Determine and disseminate appropriate sheep fattening rations
3. Research questions
3.1. How does sheep fattening reduce poverty and food insecurity for female farmers?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1. Fattening tests will be conducted for three months (2 weeks of adaptation period) at the technology parks with an active participation of the beneficiaries who are women. The fattening tests will be conducted in each area to compare four rations containing each 40% of cottonseed cake and 60% forage. The forage part (60%) of the rations will be 1) natural grass (*P. pedicellatum*) silage, 2) natural grass (*P. pedicellatum*) hay, 3) urea treated natural dry grass (*P. pedicellatum*) and 4) urea treated maize straw. Using a number of 5 heads per treatment or ration, the number of sheep needed in each area will be 20 (5 sheep x 4 rations). The total number of sheep is evaluated at 40 (20 in each area).

[41] Direction Nationale des Productions et Industries Animales. Rapport annuel 2016. 114p.

[42] Kolff,H.E., Wilson R.T., 1983. Livestock production in Central Mali: Small holder sheep fattening.The mouton de case document de travail programme zone semi-aride CIPEA, 12 p.

[43] Tangara, T. 1989 Suivi de l'embouche ovine paysanne en zone sémi aride de Banamba rapport commission technique spécialisée des productions animales. INRZFH, 12 p.

[44] Nantoumé, H., S. Sidibé, A. Sanogo, P.S. Sow, S. Cissé, A. Kouriba, A. Olivier, J. Bonneville, D. Cinq-Mars 2016. Performance et rentabilité de l'incorporation de *Ficus gnaphalocarpa* et de *Pterocarpus erinaceus* dans les rations d'embouche ovine au Mali. Revue Science de la vie, de la terre et Agronomie du CAMES 04 :01.

[45] Ballo, A. H. Nantoumé, A. Kouriba, A. Kodio et S. A. Touré 2003. Performances bouchère et économique de l'embouche ovine avec des rations à base du foin de bourgou (*Echinochloa stagnina*) ou de la paille de sorgho (*Sorghum vulgare*). *Les cahiers de l'économie rurale* 0 :19-27.

[46] Doumbia, M 1974. Essai d'engraissement intensif de trois races locales de mouton Rapport de fin d´étude, IPR Katibougou, 65p.

4.2. Forty, 12-18 months old sheep (2 adult pairs of teeth) will be bought, then vaccinated against peste des petits ruminants (PPR) and pasteurellosis and dewormed against external, internal and blood parasites using Ivermectin, Fenbendazole and Berenyl. They will adapt to the environmental conditions for two weeks and then tested for 75 days. Feed intake and weight gain will be recorded through weighing feeds on daily basis and animals will be weighed on a monthly basis and at the beginning and at the end of the experiment. Feed samples will be taken to determine the chemical composition of the rations. Costs of all the inputs and outputs will be recorded to do the economic analysis of the fattening operations.
4.3. Data analyses will be performed on feed intake, weight gain, feed efficiency and cost benefit to determine the best ration using the completely randomized design (CRD) of SAS (SAS Enterprise Guide).

5. Data to be collected and uploaded	Responsibility/Institute
5.1. Weight changes of the animals (gender disaggregated)	IER
5.2. Feed intake	IER
5.3. Feed efficiency (weight gained/unit of feed consumption	IER
5.4. Costs of inputs and outputs	IER

6. Milestones		
Choice of collaborative farmers in May, test of fattening rations and data collected from May to June reporting in August		
Deliverables	Means of verification	Date
6.1. Collaborative farmers known	Field visit. Report to be uploaded on Africa RISING West Africa Wiki page	Oct. 2017
6.2. The optimal feed ratio	Field visit. Report uploaded on Africa RISING West Africa Wiki page	Jan. 2018
6.3. Reports	Technical analyses report uploaded on Africa RISING West Africa Wiki page, economic analysis reports (cost – benefits report to be uploaded on Africa RISING West Africa Wiki page)	Jan. 2018

7. Sustainable intensification indicators	
7.1 Productivity	Animal production, input use efficiency at farm level
7.2 Environmental	Soil nutrients at farm level
7.3 Economic	Profitability, income diversification, market orientation, poverty at household level
7.4 Social	Gender equity at household level
7.5 Human	Food security, nutrition at household level

8. How will scaling be achieved?
Scaling will be achieved through working with local NGOs, FENABE, AMEDD, CAAD and GRAADCOM. Farmers will be invited to the technology parks for demonstration and participating farmers in the experiment will be working with NGOs to disseminate the technology widely.
9. How are the activities in this protocol linked to those of others?
These activities are directly related to the activities of “Test and disseminate techniques for upgrading poor forages to enhance livestock feeding during the dry season”. The activities of this

protocol are linked to those on “Feed-health interventions for improved small ruminant production” and “Evaluation of nutrition-sensitive agriculture options in Mali”. They all deal with how to improve small ruminant productivity.

8. Budget (US$)				
Outcome/Output/Activity	Sub-activity	Budget Line	ILRI	IER
Outcome 1/Output 1/Activity 2	MA1121-17	Personnel	10,000	
		Services	15,000	
		Supplies	7,373	
		Capital		
		Travel	12,627	
		Overhead	6,000	
		Total	46,000	
Outcome 1/Output 1/Activity 2	MA1122-17	Personnel		3,000
		Services		3,000
		Supplies		2,000
		Capital		
		Travel		2,000
		Overhead		1,500
		Total		11,500
Outcome 1/Output 1/Activity 2	MA1123-17	Personnel		5,000
		Services		3,000
		Supplies		2,000
		Capital		
		Travel		5,000
		Overhead		2,250
		Total		17,250
		Sub total	46,000	28,750
		Grand total	74,750	

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.3:	Test and disseminate integrated crop-livestock-soil systems to increase and sustain productivity and reduce risk.
c. Sub-activity MA1131-17	**Multi-criteria assessment and trade-off analysis of tested crop-livestock technology options at farm level, leading to options that are tailored to farmer contexts.**
d. Research team	

Name	Institution	Role
Katrien Descheemaeker	Wageningen University	Activity leader – student supervisor
Jeroen Groot	Wageningen University	Activity co-leader
Ken Giller	Wageningen University	Student supervisor
Bouba Traoré	ICRISAT	Collaborator

e. Student(s)				
Name	Institute	Start	End	
Eva Huet (PhD student)	Wageningen University	Mar. 2017	Dec.2020	

f. Location(s)	Koutiala
g. Start	July 2017
h. End	February 2018

1. Justification

Different crop-livestock intensification options and technologies have been tested in the Africa RISING project and other related research for development projects in the region. Notable examples of such options include soil fertility management technologies (such as mineral fertilizer, organic manure, including leguminous crops), fodder production, treatment and storage options, and manure and compost management, stall feeding of cattle, small ruminant fattening. Hence, information and data are available on the effects of these options on different farm components. However, an integrated analysis at the farm level, comparing the effects according to different criteria is still lacking. This activity seeks to synthesize and compile the existing information by taking into account a range of criteria and indicators that are relevant for sustainable intensification. This is important because adoption decisions by farmers depend on a wide range of performance criteria that go beyond farm productivity. Understanding farmers' perception of these criteria is key in assessing farmer decision making and will help Africa RISING researchers to design tailored interventions.

2. Objectives

2.1 To quantify the effects of previously tested crop-livestock intensification options on a range of sustainability indicators, including productivity, food self-sufficiency, nutritional value of the diet, income, and soil fertility

2.2. To inform farmers, as well as extension and development actors in the Koutiala district about the effects and about the recommendation domains for tested options

3. Research questions

3.1 What are the effects of previously tested crop-livestock intensification options on a range of sustainable intensification indicators, including productivity, food self-sufficiency, and nutritional value of the diet, income, and soil fertility?

3.2 What are the trade-offs and synergies between different domains of sustainable intensification if these options are applied?

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)

4.1. Collection of information and data from Africa RISING and other projects' experiments and other sources

Project reports, data and publications from the Africa RISING project and other related projects in the region (such as the Agro-ecological intensification project in Koutiala, funded by the McKnight Foundation and led by WUR) will be collected and useful information on the effects of the tested options on relevant farm components will be compiled. Specifically, information with regards to effects on crop yield, soil fertility, and animal productivity will be gathered and combined with a description of the input levels (labor, nutrients, fodder) required for the options. This together will

allow the calculation of productivity, environmental, economic and human indicators specified below.
4.2. Whole-farm model simulations with FARMSIM The whole-farm simulation model FARMSIM will be parameterized for farms that are representing different farm types in the region. The model allows comparing short-term effects on yield and whole-farm productivity with longer-term objectives related to e.g. soil fertility. Model outputs will serve as information that can support farmer decision-making.
4.3. Participatory workshop with male, female and young farmers A workshop will be organized with different types of farmers and household members to discuss the multi-criteria effects of the different options, for which the effects have been quantified in the previous two steps. Scientific findings will be translated into graphics for easy discussion with farmers, and farmers' feedback on their preferences and perceptions of effects will be collected. This will help to better understand farmer decision-making and the adoption potential of the options.

5. Data to be collected and uploaded	Responsibility/Institute
5.1. This activity intends to use the existing data within the project	
5.2. Simulation results on crop and livestock productivity, soil fertility	Wageningen University

6. Milestones		
Deliverables	Means of verification	Date
6.1. PhD proposal	Proposal submitted and uploaded on Africa RISING West Africa Wiki page	Jul. 2017
6.2. FARMSIM model tested	Report uploaded on Africa RISING West Africa Wiki page	Dec. 2017
6.3. multi-criteria assessment completed	Report uploaded on Africa RISING West Africa Wiki page	Feb. 2018

7. Sustainable intensification indicators	
7.1 Productivity	Crop yield per hectare, animal productivity (e.g. kg of milk per animal; number of animals sold - per animal and per farm) at farm level
7.2 Environmental	Soil organic carbon content at farm level
7.3 Economic	Gross margin at household level
7.4 Social	
7.5 Human	Food self-sufficiency, dietary diversity at household level

8. How will scaling be achieved?
Existing information about the multi-dimensional context of farming will form the basis for scaling by matching the options to context. Scaling can thus be based on a combination of the information generated in this activity on the multi-criteria performance of options in different contexts and the characteristics of the latter. The context includes information on biophysical characteristics as well as the socio-economic status of farmers captured in existing typologies.
9. How are the activities in this protocol linked to those of others?
The proposed activities link to the activities focused on crops in MA111 and on livestock in MA112. Our research may use results about the performance of tested options on the specific components of the farm and put it in a system's perspective to understand trade-offs and identify potential

synergies. The better understanding of the adoption potential generated here may help to fine-tune the activities under MA111 and MA112.

There is also a clear link with the cost-benefit and gender analysis performed under MA411., as both activities intend to take socio-economic aspects into account, thus cross-fertilizing each other.

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.1:	Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities.
b. Activity 1.1.3:	Test and disseminate integrated crop-livestock-soil systems to increase and sustain productivity and reduce risk.
c. Sub-activity MA1132-17	**Scaling out climate Information Services (CIS) use through the Participatory Integrated Climate Services for Agriculture (PICSA) approach to developing Climate-Smart Villages (CSV) in the Africa RISING site of Bougouni.**

d. Research team

Name	Institution	Role
Mathieu Ouedraogo	ICRISAT/CCAFS	Activity coordinator
Samuel T Partey	CCAFS/ICRISAT	Farmer practices assessment
Robert Zougmoré	CCAFS/ICRISAT	Technical support to the team
Bouba Traoré	ICRISAT	Facilitator - PICSA training
Andree Nenkam	ICRISAT	Facilitator - PICSA training

e. Student(s)

Name	Institute	Degree	Start	End
Boubacar Maïga	IPR/IFRA Katibougu	MSc	May 2017	Feb. 2018

f. Location(s)	Bougouni
g. Start	March 2017
h. End	December 2017

1. Justification

West Africa is known to be particularly vulnerable to climate change due to high climate variability and high reliance on rain-fed agriculture. Promotion of climate-smart agricultural (CSA) practices remains a global developmental agenda and one mainstream opportunity to deal with climate change and sustain the productivity of agricultural systems. Considering this need, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) has developed the Climate-Smart Village (CSV) approach as a means to agricultural research for development (AR4D) in the context of climate change. It is an approach where CCAFS in partnership with rural communities and other stakeholders (NARES, NGOs, local authorities), tests and validates in an integrated manner, several agricultural interventions that will be brought to scale. The CSV approach is founded on the principles of participatory action research for grounding research on appropriate and location/context-specific enabling conditions, generating greater evidence of CSA effectiveness in a real-life setting and facilitating co-development of scaling mechanisms towards landscapes, subnational and national levels. The CSV approach has six components - (1) CSA practices and technologies, (2) climate information services and insurance, (3) local and national public and private institutions, (4) national and subnational plans and policies, (5) farmers' knowledge and (6) climate

and ag-development finance. Each of the components mobilizes specific partners including research team, met services and local authorities and development partners. The component related to CIS uses several approaches including the Participatory Integrated Climate Services for Agriculture (PICSA) approach which aims to facilitate farmers to make informed decisions based on accurate, location specific, climate and weather information; locally relevant crop, livestock and livelihood options; and with the use of participatory tools to aid their decision-making.

Since 2011, CCAFS has been using the CSV approach in West Africa (Ghana, Senegal, Mali, Niger and Burkina Faso) to test and validate several agricultural interventions with the participation of various local partners. In Mali, substantial successes have been achieved over the past 4 years were through the CSV, climate information was used as an entry point for informing the choice of CSA technologies that have contributed to improved farm productivity and building resilient livelihoods for poor and marginal farmers.

In view of the priorities of Africa RISING, CCAFS will use its experiences in promoting and disseminating integrated crop-livestock-soil systems based on local climate variability for sustained productivity and reduced risk in the intervention communities. The implementation of this activity is expected to contribute to Outcome 1 of the Africa RISING phase II project: "Farmers and farming communities in the project area are practising more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets".

2. Objectives

2.1 Promote climate information use as an entry point for informing the choice of technologies and farm inputs for reduced climate-related risks and improved farm productivity.

2.2 Promote the adoption of climate-smart integrated crop-livestock-soil systems based on local needs for improved adaptive capacity to climate change and variability

3. Research questions

3.1 How does provision and use of CIS influence farm management decisions (e.g. choice of technologies, timing of farm operations, choice of farm inputs etc.)

3.2 How do CIS-informed farm decisions improve farm productivity and livelihoods of smallholder farmers?

Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.).

Farmers will be involved in a participatory manner. The PICSA approach is a top down, bottom up participatory approach that intends to enhance the farmers'decision-making process by providing climate information to alongside other tools.

Farmers get the advice through meetings with the field agents. The information includes locally specific climate historical information (historical time series graphs – start and end of the rainy season, seasonal rainfall totals, length of the rainy season and number of rainy days) which helps farmers to better understand the climate for their locality and calculate risks of various events happening and therefore make informed decision and plan for the next rainy season. It also involves participatory tools individually designed by farmers for farmers but facilitated by field agents. And these tools help farmers to evaluate/plan the former/next cropping season. One of the tools provides a wide range of context-specific options (crop, livestock or other livelihood options) to the farmers and how these are influenced by the weather. These options are developed by both the farmers and the field agents

The activities will include the following :
4.1 Training of farmers and extension services agents in PICSA approach
4.2 Monitoring and evaluation of the use of PICSA approach by farmers
4.3 Establishment of climate-smart village

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Historic weather information will be collected throughout the study	CCAFS
5.2 Farmers perceptions on climate variability and farmers practices	CCAFS
5.3 Changes in farmers' practice due to the use of PICSA through monitoring and evaluation surveys of farmers involving in the implementation of the PICSA approach (refer to 4.2)	CCAFS

6. Milestones

Deliverables	Means of verification	Date
6.1. 10 extension agents trained in PICSA approach by PICSA experts through a training of trainers	Training workshop report uploaded on Africa RISING West Africa Wiki page	Dec. 2017
6.2. 200 Farmers including at least 30% of women from 4 Africa RISING villages in Bougouni (Dieba, Flola, Madina, Sibirila) trained in PICSA implementation by extension agents wh0 received the training from PICSA experts	Training workshop report uploaded on Africa RISING West Africa Wiki page	Dec. 2017
6.2. 200 Farmers including at least 30% of women from 4 Africa RISING villages in Bougouni (Dieba, Flola, Madina, Sibirila) received climate information through the climate forecast communication workshop (face to face meetings with PICSA experts and extension agents)	Activity report uploaded on Africa RISING West Africa Wiki page	Nov. 2017

7. Sustainable intensification indicators

7.1 Productivity	Yield at household level
7.2 Environmental	
7.3 Economic	Profitability, income diversification at household level
7.4 Social	
7.5 Human	

8. How will scaling be achieved?
Scaling will be achieved through strategic partnership with development partners including national extension services, development projects and NGOs. For this purpose, technicians from national extension services, development projects and NGOs will be trained in PICSA approach and will be used as trainers for PICSA rolling with farmers. These stakeholders (national extension services, development projects and NGOs) will contribute to upscale PICSA approach through their own activities. The trained farmers also will contribute to scaling out PICSA approach to more farmers.
9. How are the activities in this protocol linked to those of others?

The implementation of PICSA approach is an entry point for farmers to mainstream climate information into their activities. So, this project will inform farmers on what technologies and practices they could use to take a decision regarding the climate change issue. Therefore, all the technologies and practices developed through other activities of Africa RISING project should be seen as a basket of potential options for decision-making in the context of climate change and variability. The activities MA1113-17 and MA1115-17 can provide technologies for farmer's decision-making.

8. Budget (US$)				
Outcome/Output/Activity	Sub-activity	Budget Line	WUR	ICRISAT
Outcome 1/Output 1/Activity 3	MA1131-17	Personnel	4,500	
		Services		
		Supplies	2,500	
		Capital		
		Travel	500	
		Overhead	1,125	
		Total	8,625	
Outcome 1/Output 1/Activity 3	MA1132-17	Personnel		5,000
		Services		500
		Supplies		10,000
		Capital		
		Travel		4,500
		Overhead		3,000
		Total		23,000
		Sub total	8,635	23,000
		Grand total	31,635	

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.2:	Integrated management technologies and practices to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated to farmers and development partners in the intervention communities.
b. Activity 1.2.1:	Test and disseminate land, soil and integrated land-soil technologies and practices to improve and sustain productivity and ecosystems services at the farm and landscape/watershed levels.
c. Sub-activity MA1211-17:	**Investigate the impact of land and water management practices overtime on the productivity and economic benefits of cereal crops (sorghum and maize) in different agro-ecologies.**
d. Research team	

Name	Institution	Role
Birhanu Zemadim	ICRISAT	Leader, Land and Water Management
Ramadjita Tabo	ICRISAT	Agronomist
Felix Badolo	ICRISAT	Economist
Mahamadou Dicko	ICRISAT	Bougouni site coordinator

Karamoko Traore	ICRISAT	Koutiala site coordinator
Oumar Samake	AMEDD	Agronomist

e. Student(s)

Name	Institute	Degree	Start	End
Intern (BSc)	IPR/IFRA Katibougu	BSc	Jul. 2017	Feb. 2018

f. Location(s)	Koutiala and Bougouni
g. Start	March 2017
h. End	January 2018

1. Justification

Land and water management practices like that of contour bunding, drip irrigation and shallow wells have been implemented by farmers over time in southern Mali. Farmers use these practices to improve yield performance and increase the household income (Gigou, J., et al., 2006[47]; Birhanu, Z.B. and Tabo, R., 2016 [48]). Literature shows that the implementation of contour bunding can improve cotton yield by 30% and reduce erosion rate by 40% at farmers' field level (Traoré, K.B., et al., 2004[49]; Birhanu, Z., 2015[50]). This work was mainly done through the cotton expansion program by the state-owned company in the past ten to fifteen years. However, there is a lack of information on the impact of land management practices, mainly contour bunding and use of shallow wells, on cereal crops productivity over time. Cereal crops are the major staple food crops for rural Malians. In the current study, the impact of land and water management practices will be evaluated on two major staple food crops (sorghum and maize) grown in two agro-ecologies of southern Mali. The data collected will be augmented with data collected in 2015 and 2016. In the current year, data will be collected from the four established technology parks in Bougouni and Koutiala.

2. Objectives

2.1 Evaluate the impact of land and water management practices on the productivity and economic benefits of cereal crops (sorghum and maize) in different agro-ecologies

3. Research questions

3.1 What variations exist over time on cropping performance (yield and biomass) as a result of introduced land management practices?

3.2 What is the economic advantage of using improved land and water management technologies

3.3 By what rate soil moisture is enhanced with the introduced land and water management practices and how will it help bridge dry spells and improve crops maturity?

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)

[47] Gigou, J, Traoré, K., Giraudy, F., Coulibaly, H., Sogoba, B., & Doumbia, M. (2006). Aménagement paysan des terres et réduction du ruissellement dans les savanes africaines. *Cahiers Agricultures*, 15, 116-122.

[48] Birhanu, ZB. & Tabo, R. (2016). Shallow wells, the untapped resource with a potential to improve agriculture and food security in southern Mali. *Agric. & Food Secur*, 5:5.

[49] Traoré, KB. Gigou, JS. Coulibaly, H., & Doumbia, MD. (2004). Contoured ridge-tillage increases cereal yields and carbon Sequestration. In: 13th International Soil Conservation Organisation Conference, Brisbane July 2004, Conserving Soil and Water for Society: Sharing Solutions, 126, 10pp.

50 Birhanu Zemadim 2015, Contours of a success story, Expanding Contour Bunding Technology for Improved Livelihood Benefits in Mali, Inclusive Market Oriented Development. Demand Driven Innovation Benefitting the Poor. ICRISAT IMOD Exemplars, Vol (2) pp 75-82. http://www.icrisat.org/PDF/IMOD-Exemplars-Volume-II.pdf

4.1. Different agro-ecological characterizations will be conducted based on the available biophysical information. Here the watershed approach will be used to characterize the different agro-ecologies using the following information; population density, number of households, soil type, climate pattern, market access, number and type of past natural resources management practices, slope and land use pattern.
4.2 Field experiments will be designed and effectuated to establish treatment and control fields in the four technology parks with respect to improved land and water management techniques and farmers' practice. Agronomic performance and economic advantage of improved land and water management technologies will be evaluated in the established treatment and control fields. In addition, soil water content at different depths (100 mm, 200 mm, 300 mm, 400 mm, 600 mm, and 1,000 mm) will be recorded from both treated and control fields in different seasons to evaluate the soil water availability.

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Agronomic	ICRISAT/AMEDD
5.2 Soil moisture, water runoff and soil nutrient	ICRISAT/IER
5.3 Economic, input cost, profitability	ICRISAT/AMEDD

6. Milestones

Deliverables	Means of verification	Date
6.1 Data on agronomic, soil moisture and land use changes	Uploaded on Dataverse	Jan. 2018
6.2 Conference paper prepared on the topic: Soil and Water Conservation	Poster or Oral presentation	Jan. 2018
6.3 Economic analysis report of long-term CBT impact	Report uploaded on Africa RISING West Africa Wiki page	Feb. 2018

7. Sustainable intensification indicators

7.1 Productivity	Yield of crops (kg/ha/season), residue production (kg/ha/season), variability of production (coefficient of variability) at farm level
7.2 Environmental	Soil moisture, Infiltration rate, percentage of plants wilting, erosion (tons/ha/year), rating of erosion, soil nutrient levels, bulk density, water holding capacity at plot level
7.3 Economic	Net income ($/crop/ha/season), coefficient of variability of net income, probability of low profitability, inputs per hectare, labor requirement (hours/ha), farmer rating of labor at household level
7.4 Social	
7.5 Human	

8. How will scaling be achieved?
Scaling is achieved through field demonstration of technologies perceived important by farmers. During phase I of the project we have already established that contour bunding associated with agroforestry options are suited for scaling. Local NGOs, AMEDD and FENABE, have received appropriate training to scale the technology to a number of farmers.
9. How are the activities in this protocol linked to those of others?
This activity is linked to most agronomic and soil fertility improvement sub activities proposed in the current study.

Outcome 1:	Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.2:	Integrated management technologies and practices to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated to farmers and development partners in the intervention communities.
b. Activity 1.2.1:	Test and disseminate land, soil and integrated land-soil technologies and practices to improve and sustain productivity and ecosystems services at the farm and landscape/watershed levels.
c. Sub-activity MA1212-17:	**Evaluating land ownership and technology adoption: Evidence from Southern Mali using the AR baseline data.**

d. Research team:

Name	Institution	Role
Sankara Moussa	ICRISAT	Conduct analysis and write-up
Birhanu Zemadim	ICRISAT	Technical support
Beliyou Haile	IFPRI	Technical support
Carlo Azzarri	IFPRI	Technical support

e. Student(s)

Name	Institute	Degree	Start	End

f. Location(s)	Mali
g. Start	March 2017
h. End	December 2017

1. Justification

Studies in West Africa countries showed that land tenure may have an impact on agricultural investment (e.g., in Ghana (Besley, 1995[51]); in Niger (Gavian. and Fafchamps, 1996[52]); in Burkina Faso (Braselle et al., 2002[53])). Farmers' decision to invest in a given land depends on how secure their rights are, the ability to make long time use of that land and the possibility to sell the land at any time. In Mali land tenure rights have been identified as a challenge in agricultural investment (Djiré et al., 2012)[54]. To meet that challenge, land tenure security has been adopted as a policy to enhance agricultural investment and productivity by the government of Mali. Therefore it becomes important to determine the relationship between land ownership and agricultural investment (technology adoption) in Mali. This study aims to investigate the extent to which land ownership and other socioeconomic variables have an impact on technology adoption, especially those promoted by the Africa RISING project.

51 Besley, T. 1995. "Property Rights and Investment Incentives: Theory and Evidence from Ghana," Journal of Political Economy, 103(5):903-37

52 Gavian, S. and Fafchamps, M.,. 1996. "Land Tenure and Allocative Efficiency in Niger," American Journal of Agricultural Economics, 78(2): 460-71

53 Brasselle, A.S., Gaspart, F. and Platteau, J.P. and al, 2002: Land tenure security and investment incentives: puzzling evidence from Burkina Faso. Journal of Development Economics Vol. 67 (2002) 373–418

54 Djiré, M. avec la collaboration de Keita, A. et Diawara, A. (2012) Investissements agricoles et acquisitions foncières au Mali: Tendances et études de cas. IIED/GERSDA, Londres/Bamako

2. Objectives
2.1 Determine the effects of land ownership on technology adoption, especially those promoted by AR
2.2 Determine the effects of socioeconomic and institutional variables that influence technology adoption, especially those promoted by AR
2.3 Determine the effects of other variables such as being a member of an association on technology adoption
3. Research questions
3.1 Do land ownership, socio-economic, institutional and other variables: cultural, and biophysical constraints have an influence on technology adoption?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1 Data for this study come primarily from Mali Africa RISING Baseline Evaluation Survey (MARBES). In addition, we will use secondary data from other sources. MARBES has plot-level data on the type of ownership (private, communal, rented, and sharecropped) and community-level self-reported data on land insecurity. The MARBES covered 700 households (350 treatment and 250 control households) in 40 villages (20 for treatment and 20 for control). To investigate the relationship between land tenure security and other socio- socioeconomic, institutional variables on technology adoption, a multivariate Probit model will be used.

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Not applicable	

6. Milestones

Deliverables	Means of verification	Date
6.1 Report	Report uploaded on Africa RISING West Africa Wiki page	Sep. 2017
6.2 A Peer-reviewed manuscript entitled “Evaluating Land ownership and Technology Adoption” will be prepared	Submission to TSI Journal	Nov. 2017

7. Sustainable intensification indicators

7.1 Productivity	Not applicable
7.2 Environmental	Not applicable
7.3 Economic	Not applicable
7.4 Social	Not applicable
7.5 Human	Not applicable

8. How will scaling be achieved?
Results of the study will help to develop and amend a scaling strategy proposed for Africa RISING phase II implementation. In addition, as the current study uses previously collected data from Africa RISING phase I, through detailed analysis it provides guidance on newly collected information and ensures the reliability of further data collection.
9. How are the activities in this protocol linked to those of others?

This activity is led by the M&E expert of the program and hence he will make sure that other sub-activities are linked to the data type that was collected previously during Africa RISING phase I.

Outcome 1:	Farmers and farming communities in the project area are practising more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets.
a. Output 1.2:	Integrated management technologies and practices to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated to farmers and development partners in the intervention communities.
b. Activity 1.2.1:	Test and disseminate land, soil and integrated land-soil technologies and practices to improve and sustain productivity and ecosystems services at the farm and landscape/watershed levels.
c. Sub-activity MA1213-17:	**Improving crop-livestock productivity and household income through the use of contour bunding and agroforestry options.**

d. Research team

Name	Institution	Role
Kalifa Traore	IER	Protocol, data processing, reporting
Oumar Samake	IER	Implementation, data collection and record

e. Student(s)

Name	Institute	Degree	Start	End
Cheick Oumar Dembele	IER	PhD	Mar. 2017	Feb. 2020
Fotigui Tamboura Cisse	IER	MSc	Mar. 2017	Feb. 2018

f. Location(s)	Bougouni and Koutiala
g. Start	March 2017
h. End	December 2017

1. Justification

Key elements to ensure sustainability of agriculture-livestock systems are the adequate production of quality forage for animal supplementation but also the availability of water and soil nutrients (Penning de Vries and Djiteye, 1982[55]). Among these quality forages, fast-growing nitrogen-fixing tree species and herbaceous plants occupy a prominent place. The power to concentrate and save nutrients, produce and maintain high biomass quantity exceeds far that of cereals and other grass species (Breman and Kessler, 1995[56]). Not all the fast growing nitrogen fixing trees (FGNFT) are acceptable to livestock because of nitrogen content and availability.

[55] Penning de Vries F.W.T., Djiteye M.A. (1982). La productivité des pâturages sahéliens. Une étude des sols, de végétations et de l'exploitation de cette ressource naturelle. Agric. Res. Rep (Vers1. Landbouwk Onderz0 918. 525 p.

[56] Breman, H. and Kessler, J.J., 1995b. Woody plants in agroecosystems of semiarid regions. Springer, Berlin, p. 340.
German, L. Mansoor H., Alemu G., Mazengia W., Amede T. and Stroud A. 2007. Participatory integrated watershed management: Evolution of concepts and methods in an ecoregional programme of the Eastern African highlands. Agricultural Systems 94, 189-204.

A study on fodder yield and nutritive value of many trees species in West African humid areas (Larbi et al., 2005[57]) showed that *Gliricidia sepium and Leucaena leucocephala,* were identified to have high potential for the development of integrated crop-livestock agroforestry technologies because of fodder yield, concentrations of CP, NDF, ADF and lignin. Coppicing regrowth of these species could be harvested between 16 and 20 weeks to maximize yield and quality of the fodder. In Western Kenya, a biomass yield of 21 tons ha^{-1} was observed with Sesbania sesban on many nutrient-depleted soils (Sjogren et al., 2010[58]). It is in this context that we propose to study possibilities of introducing fast-growing forage tree species in farmers' fields under Contour Bunding (CB) techniques. During the monitoring period, water storage was always higher in CB plots compared to control plots with a surplus of 0.23 mm day^{-1} in 2012 and 0.43 mm day^{-1} in 2013 in the Cinzana Sahelian area of Mali[59]. Also, millet grain yields in 2012, 2013 and 2014 were statistically higher in CB plots compared to the control with yield difference ranging from 301 kg ha^{-1} in 2012 to 622 kg ha^{-1} in 2013. These values corresponded to an increase of 60 and 56%, respectively. Concerning sorghum grain yield, it increased consistently from 461 kg ha^{-1} in 2012 to 1,378 kg ha^{-1} in 2014. Moreover, the qualitative assessment done by farmers on the effects of CB revealed that rainwater was kept between contour ridges reducing runoff and consequently increasing infiltration and producing higher crop yields (grain and straw) in contoured plots than in the control plots. Also, with the use of CB, soil moisture was found to be better conserved which allowed field operations for an extended 7 to 10 days (Traore et al.,2017a[60]).
2. Objectives
2.1 Monitor growth and quantify forage production of fast-growing trees species *(Gliricidia sepium and Leucaena leucocephala)*
2.2 Increase crop yield through improving rainwater conservation in improved cropping systems
2.3 Study the effects of fast-growing tree species on soil physicochemical properties
3. Research questions
3.1 How can the use of Contour Bunding Technology (CBT) increase crop grain and straw biomass yield?
3.2 Does the use of CBT increase trees growth and biomass?
3.3Does the use of CBT improve soil physical and chemical properties?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1 Twenty collaborative farmers will be chosen in two villages because this number is what is feasible with accurate data according to the experiment type. Prior to implementation, soil sampling will be performed using an auger at 0-20 cm and 20-40 cm depth and samples will be sent for physicochemical analysis in the Soil-Water - Plant Laboratory of IER. The field of each farmer will be divided into two parts. The first part is under contour bunding (CB), i.e. ridges follow contour lines, and the second one with farmer's practices labeled as non-contour

[57] Larbi, A. ; Anyanwu, N. J. ; Oji, U. I. ; Etela, I. ; Gbaraneh, L. D. ; Ladipo, D. O., 2005. Fodder yield and nutritive value of browse species in west African humid tropics: response to age of coppice regrowth. Agroforestry Systems, 65: 197-205. doi:10.1007/s10457-005-0922-x

[58] Sjögren, H., Shepherd, K.D., Karlsson, A. 2010. Effects of improved fallow with Sesbania sesban on maize productivity and Striga hermonthica infestation in western Kenya. Journal of Forestry Research 21: 379-386.

[59] Traore K., Sidibe D.K., Coulibaly H., Bayala J. 2017. Optimizing yield of improved varieties of millet and sorghum under highly variable rainfall conditions using contour ridges in Cinzana, Mali. *Agriculture and Food Security,* 6:11. DOI 10.1186/s40066-016-0086-0.

[60] Traore K., Sidibe D.K., Coulibaly H. 2017. Climate Smart Agriculture as Final Goal: Use of Improved Cereals Varieties in Cinzana, Mali. Journal of Agricultural Studies, Vol. 5, No. 1. doi:10.5296/jas.v5i1

bunding (NCB) implemented as a control. The contour lines will be planted with fast-growing trees species chosen by farmers, such as *Gliricidia sepium* and *Leucaena leucocephala*. Trees species will be planted on the crest of the contour bund which will be 0.8 m width and 100 m length. The distance between trees species will be 3 m. Trees will not be planted in the 10 x 4 m plot but along the contour bund. Therefore, 17 trees will fit into a 40 m^2 area along the contour bund. In each part, trials based on cotton or maize intercropped with soybean will be implemented. In each trial only the inputs (fertilizer, pesticides) will be supplied by researchers, all the other factors (crop species, varieties, tillage technique, maintenance, etc.) will be those of farmers. In two fields, soil moisture will be monitored using TDR probes in CB and NCB plots.

4.2 Data will be analyzed using STATBOX 7. Analyze of variance will be used to assess the performance of treatments and means comparison by LSD procedure.

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Biophysical data: height, basal diameter, crown radius and diameter at 1.3 m height when possible) will be performed on fast-growing trees species starting at their plantation date.	IER
5.2 Cultural operations: Plowing or ridging date, planting date, emergence date, thinning date, planting density, plant density at harvest, plant height, grain yield, straw yield, thousand grain yield.	IER
5.3 Soil physical and chemical properties	IER
5.4 Soil moisture content	IER
5.5 Trees biophysical parameters	IER
5.6 Crop yield (straw and grain)	IER

6. Milestones

Deliverables	Means of verification	Date
6.1 Report	Interim report submitted to ICRISAT	Dec. 2017
6.2 Data on agronomic and tree	Data uploaded on Dataverse	Dec. 2017
6.3 Recommendation of Best agro-forestry technology in combination with CBT	Report and brief to be uploaded on Africa RISING West Africa Wiki page	
6.4 Farmer exchange visit	Field visit, technical report and IER's yearly Committee of Program report uploaded on Africa RISING West Africa Wiki page, pictures (photo and film)	Dec. 2017 (Africa RISING technical report) and June 2018 (IER's yearly Committee of Program report)

7. Sustainable intensification indicators

7.1 Productivity	Crop production, input use efficiency, cropping intensity at farm level
7.2 Environmental	Soil quality (nutrients level) at plot level
7.3 Economic	Profitability, returns to land, labor and inputs, diversification of income sources at household level
7.4 Social	Gender equity, social cohesion at household level
7.5 Human	Livelihoods

8. How will scaling be achieved?

In September, when there is very little field work, a farmer exchange visit will be organized to show the growth and development of the different fast-growing tree species planted on the

crest of the contour line. They will be trained on how and when to start the nursery and trees plantation. In each village, at least 40 farmers will be part of the exchange visits. Farmers who have developed an interest in the technology will be recorded and new materials will be made available for them.
9. How are the activities in this protocol linked to those of others?
This activity is linked to improving crop and livestock breeding practices to help agricultural activities and also small ruminant fattening. For instance, coppicing can be done when ploughing, ridging and sowing using oxen will start since at that period there is a forage shortage for animals.

8. How will scaling be achieved?
In September, when there is very little field work, a farmer exchange visit will be organized to show the growth and development of the different fast-growing tree species planted on the crest of the contour line. They will be trained on how and when to start the nursery and trees plantation. In each village, at least 40 farmers will be part of the exchange visits. Farmers who have developed an interest in the technology will be recorded and new materials will be made available for them.
9. How are the activities in this protocol linked to those of others?
This activity is linked to improving crop and livestock breeding practices to help agricultural activities and also small ruminant fattening. For instance, coppicing can be done when ploughing, ridging and sowing using oxen will start since at that period there is a forage shortage for animals.

8. Budget (US$)					
Outcome/Output/Activity	Sub-activity	Budget Line	ICRISAT	IER	AMEDD
Outcome 1/Output 2/Activity 1	MA1211-17	Personnel	4,000		7,500
		Services	4,000		2,500
		Supplies	11,000		2,000
		Capital			
		Travel	1,000		3,000
		Overhead	3,000		2,250
		Total	23,000		17,250
Outcome 1/Output 2/Activity 1	MA1212-17	Personnel			
		Services			
		Supplies			
		Capital			
		Travel			
		Overhead			
		Total	0	0	0
Outcome 1/Output 2/Activity 1	MA1213-17	Personnel		4,000	
		Services		2,000	
		Supplies		3,000	
		Capital			
		Travel		1,000	
		Overhead		1,500	

		Total		11,500	
Outcome 1/Output 2/Activity 1	MA1214-17	Personnel	4,000	2,000	
		Services	2,000	6,000	
		Supplies	3,000	5,000	
		Capital			
		Travel	1,000	2,000	
		Overhead	1,500	2,250	
		Total	11,500	17,250	
		Sub total	34,500	28,750	17,250
		Grand total	80,500		

Outcome 2: More farmers and farm families in the intervention communities are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling and value addition.

a. Output 2.1:	Improved technologies, practices and habits to increase and diversify the production and consumption of more nutritious food by farm families, especially by women and children are developed.
b. Activity 2.1.1:	Develop a nutrition strategy to harmonize the nutrition activities with the national nutrition approaches and link them to the crop and livestock activities.
c. Sub-activity MA2211-17:	**Evaluation of nutrition-sensitive-agriculture options in Mali.**

d. Research team

Name	Institution	Role
Augustine Ayantunde	ILRI	Lead Livestock component
Caroline Makamto Sobgui	WorldVeg	Lead Nutrition component Mali
Jean-Baptiste Tignegre	WorldVeg	Lead Vegetable component Mali
Nantoume Hamidou	IER	Animal nutritionist
Pierre Coulibaly	AMEDD	Field technician

e. Student(s)

Name	Institute	Degree	Start	End
To be identified in Ghana	WorldVeg/ILRI/IER	PhD	Jul 2017	Feb 2020
To be identified in Mali	WorldVeg/ILRI/IER	PhD	Jul 2017	Feb 2020

f. Location(s)	Project communities in Mali (to be implemented by a PhD student funded by Africa RISING in Mali)
g. Start	2017
h. End	2021

1. Justification

Agricultural practices and interventions can be improved and redesigned to maximize health and nutrition benefits and to reduce malnutrition and diseases. In Sikasso Region, the prevalence of under-nutrition and micronutrient deficiencies remains unacceptably high despite being tagged as “the breadbasket of Mali”.

The importance of consumption of animal source food (ASF) for cognitive development of children is well documented. For example, a nutritional study in Gourma in northern Mali

showed that the children of mobile pastoralists were better nourished based on weight-height, weight-age and height-age measurements than the children of sedentary farmers and that the children of the sedentarized pastoralists seem to be worst off (Pedersen and Benjaminsen, 2008[61]). The children under these studies were 6 to 60 months of age. The explanation for this trend was largely attributed to the consumption of milk.

This underscores the important role that livestock systems play in human nutrition as the households that keep livestock are more likely than their non-holding counterparts to consume ASF because of their proximity to the nutrient-rich foods. Increased consumption of ASF by the rural households may prevent or reduce stunting in children and will improve the health of the households, particularly of children and vulnerable women. Thus, there is a need for increased consumption of animal source food by the households in crop-livestock systems in Africa RISING intervention communities where staple food is largely based on cereals. One pathway to improve the consumption of ASF is through the improvement of livestock production; for example, improved milk and meat by ruminants (cattle, sheep and goats) and non-ruminants (poultry and pigs), and egg production by poultry. As the women are known to play key roles in household nutrition, livestock-related nutrition interventions should be gender-sensitive.

In addition to ASF, consumption of other nutritious food and vegetables is necessary and will be addressed in this study. Bringing together agriculture, nutrition and health will help to address the immediate and underlying cause(s) of malnutrition and nutrition insecurity in the Africa RISING intervention communities. In addition to interventions to improve household nutrition, there will be a focus on building capacity in best nutrition practices and nutrition behavior change communication targeted at women to foster the creation of an environment where women feel comfortable to change and adopt best nutrition practices.

2. Objectives
2.1 The overall objective of this integrated livestock-vegetable-nutrition activity is to evaluate the effects of the improved intensification options, such as livestock-related and vegetable-related nutrition interventions on household nutrition, particularly of children and women of reproductive age. The specific objectives are: (i) To characterize nutrition practices of the households in the study areas and quantify gender-differentiated roles in household nutrition practices; (ii) To assess the effect of livestock productivity enhancing interventions and vegetable production in home-gardens on household nutrition particularly children under 2 years. The underlying hypothesis is that productivity-enhancing intensification options will lead to improvement of household food security and nutrition thereby enhancing gender equity.
2.2: To assess the effects of the improved intensification options with and/or without nutrition education on maternal and child nutritional status and child care practices.
2.3: To assess the effects of the improved intensification options with and/or without nutrition education on agricultural income and workload.
3. Research questions
3.1. How and when do improved intensification options with and without nutrition education impact on maternal and child nutritional status and child care practices?
3.2. How and when do improved intensification options without nutrition education impact on household income from agriculture and workload of mothers?
3.3 What are the effects of the livestock-related intervention on vegetable production (home-garden: diversity and quantity)?

[61] Pedersen, J., and T. Benjaminsen. 2008. One leg or two? Food security and pastoralism in the Northern Sahel. Human Ecology 36: 43–57.

3.4 Does social mobilization for nutrition and health create an avenue where young women are empowered to adopt best nutrition practices?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1. Community-based intervention using a quasi-experimental design with a baseline survey and an end of project survey. The study will be conducted in 4 Africa RISING intervention communities and will involve focus group discussions and individual surveys to collect gender-disaggregated data on roles of gender in household nutrition and to characterize household nutrition practices of the selected households. A cluster-randomized controlled intervention trial will be used with an intervention group in 2 communities in Koutiala District and a non-intervention group in another 2 communities in Koutiala District. A survey of marketed foods in the study areas will be conducted as available food types in the markets and price may influence household nutrition and diet diversity. To establish dietary diversity of selected households, surveys will be executed that quantify the Minimum Diet Diversity for Women (MDD-W) score, and infant and young children feeding practices (children dietary diversity score, minimum acceptable diet). In addition, anthropometric (weight for age/height, height for age) measurements of children in selected households in the study areas will be carried out. Project interventions will include the introduction of livestock (e.g., dairy goat, domestic chicken or guinea fowl) breeds to the intervention communities after assessment of performance on-station. The dairy goats and domestic chicken or guinea fowls will be given to selected women in 2 project communities in Koutiala to manage after training in improved husbandry practices while 2 other communities in Koutiala where there is no intervention will serve as the control. The women are targeted to ensure that the milk and eggs produced will go into household nutrition, particularly for consumption by children under 5 years. In addition to livestock intervention, vegetable gardening will be established by the women involved in the treatment communities using manure from the livestock to enhance soil fertility. They will also be trained in improved cooking practices for preparing the vegetable(s) grown for household consumption. The manure from goats will be collected and applied to the vegetable garden. The trained women are expected to have gained knowledge about gardening and animal husbandry thereby getting a better understanding of how agricultural interventions can improve family nutrition and health. This is expected to motivate the women to actively participate in the study. Behavior change communication (BCC) group sessions on improved nutrition and cooking demonstrations (aimed at optimizing the nutritional quality) will be held and targeted at beneficiaries, in particular women of reproductive age. Community mobilization activities will be organized in targeted villages with selected groups including local stakeholders, and groups of men and grandmothers. A quasi-experimental design will be used to evaluate the impact of this intervention on target communities by using the data collected during the baseline and the end of project survey. Gender disaggregated data will be collected during monitoring activities and surveys.

5. Data to be collected and uploaded in Dataverse	Responsibility/Institute
5.1. Survey data on gender roles in household nutrition and household nutrition practices	WorldVeg/ILRI/IER
5.2. Monitoring data household nutrition (consumption of different food types)	WorldVeg/ILRI/IER
5.3 Animal performance data	ILRI/IER

5.4 Vegetable production data	WorldVeg/ILRI

6. Milestones		
Deliverables	Means of verification	Date
6.1. Baseline survey data (quantitative and qualitative)	Report submitted and data upload in Dataverse	May 2018
6.2. On-station assessment of the productive performance of improved dairy goat and domestic chicken/guinea fowl, and development of feed package for the dairy goat	Report submitted to Africa RISING Coordination unit and published on CGSpace	May 2018
6.3 Establishment of home garden (nutrition garden) and monitoring	Reports/brief on home gardening to be uploaded on Africa RISING West Africa Wiki page /	Apr. 2018
6.4 Training in best nutrition practices and improved animal husbandry	Reports submitted to Africa RISING Coordination unit and uploaded on Africa RISING West Africa Wiki page	Jan. 2018
6.5. End of project survey data (quantitative and qualitative)	Report submitted to CGSpace and data uploaded in Dataverse	May 2020
6.6. Articles published on the topic, (i) The effect of livestock interventions on household security and diet diversity, (ii) Effect of manure and fertilizer on productivity and profitability of vegetable crops".	At least two articles published; Target Journal: Agronomy for Sustainable Development	Dec. 2020

7. Sustainable intensification indicators	
7.1 Productivity	Increased production of proteins at farm level
7.2 Environmental	Increased and improved use of animal manure produced at farm level
7.3 Economic	Economic benefits of nutrition garden and livestock interventions at household level
7.4 Social	Increased capacity of trainees to work and learn together in the food production and consumption sector
7.5 Human	Improved capacity and skills of women of childbearing age on child nutrition

8. How will scaling be achieved?
Scaling up nutrition and agricultural interventions entails identifying those programs and practices of proven efficacy and applying management, communications, and monitoring principles and tools to expand the number of beneficiaries. During the process of scaling-up, given resource constraints and as a good management practice, it is often necessary to prioritize groups that have a more urgent need (in this case the most undernourished children and women of reproductive age). The main platforms through which nutrition interventions can be scaled up are health systems (where the government is usually in the lead and the private sector also has a role) and food systems (where the private sector is most active but the government has an important role to play). Findings from the study may provide insights into how prenatal food-based interventions can positively influence postnatal growth through women empowerment in agriculture production of ASF. It is therefore expected that any positive findings will be scaled-up through key stakeholders such as the Ministries of Health and Agriculture, and the NGOs involved in nutrition education.

9. How are the activities in this protocol linked to those of others?
Activities will be implemented jointly by a multi-disciplinary team and the livestock and vegetable production interventions in this study will be linked to other activities such as feed and health interventions for improved small ruminant production and profitable vegetable production.

8. Budget (US$)						
Outcome/Output/ Activity	Sub-activity	Budget Line	ILRI	WorldVeg (Nutrition)	WorldVeg (Vegetable production)	AMEDD
Outcome 2/Output 1/Activity 1	MA2111-17	Personnel	38,000	15,000	10,000	5,000
		Services	27,575	10,000	5,000	3,000
		Supplies	25,000	15,000	10,000	2,000
		Capital	0			
		Travel	14,000	10,000	5,000	5,000
		Overhead	15,686	8,800	5,280	2,250
		Total	120,261	58,800	35,280	17,250
		Grand total	231,591			

Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies.

a. Output 3.1:	Improved policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are developed.
b. Activity 3.1.1:	Review existing policies and institutional arrangements affecting equitable access to production assets and markets.
c. Sub-activity MA3111-17:	**Literature review of existing policies and institutional arrangements affecting access to production assets and markets.**

d. Research team

Name	Institution	Role
Ousmane Sanogo	IER, Sikasso	Collect data and conduct technical analysis
Badolo Felix	ICRISAT	Contribute to data collection and technical analysis
Louis Dena	IER, Sikasso	Contribute to data collection
Moussa Sanogo	IER, Sikasso	Contribute to data collection

e. Student(s)

Name	Institute	Degree	Start	End
MSc candidate to be identified	IPR/IFRA Katibougu	MSc	May 2017	Feb. 2018

f. Location(s)	Koutiala and Bougouni
g. Start	March 2017
h. End	January 2018

1. Justification

Very few data exist on policies and institutional arrangements on access to production assets and markets. The objective of this study is to provide updated information and fill the gap compared to the current situation.

2. Objectives

2.1 Provide updated information and fill the gap on policies and institutional arrangements

3. Research questions

3.1 What are the current political barriers to access the production assets and markets?

3.2 At what segment of the value chain do the identified policies and institutional arrangement support or inhibit access?

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.

4.1 Literature review of the current situation
The literature review will examine existing policy documents and institutional arrangements that address equitable access of women and youth to production assets and market. This literature review can mainly take place at the level of DRA-Sikasso (Regional Directorate of Agriculture) and Regional Research Center of Sikasso (IER) and Bamako libraries, which have important documentary databases but also various resource persons.

4.2 Interview policymakers and focal points regarding the institutional arrangements
A questionnaire will be developed and issues related to equitable access of women and youth to production assets (input and output) and the market will be assessed. A total of fifteen policymakers (the Chamber of Agriculture, Regional Direction of Agriculture, District agents, Heads of Agriculture) will be interviewed

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Secondary data on existing policies, production and market	IER
5.2 Survey data	IER
5.3	

6. Milestones

Deliverables	Means of verification	Date
6.1 Report on political barriers to access to production assets and markets	Report and MSc thesis submitted to ICRISAT	Sep. 2017
6.2 Report on recommendations to improve access of women and youth to production assets and the market	Report and MSc thesis, policy brief, policy recommendations submitted to ICRISAT and uploaded to Africa RISING Wiki page	Nov. 2017
6.3 Report on analytical review of policies and institutional arrangements in Mali	Research paper submitted to the journal	Jun. 2018

7. Sustainable intensification indicators

7.1 Productivity	Not applicable

7.2 Environmental	Not applicable
7.3 Economic	Not applicable
7.4 Social	Variability and distribution between men and women concerning productivity, income and assets at village level
7.5 Human	Not applicable

8. How will scaling be achieved?
Scaling up will be achieved through partnership with development services. Dissemination strategies will include: development of communication materials such as posters for extension agents and farmers, and policy brief for policymakers.
9. How are the activities in this protocol linked to those of others?
Activities have links with those on outcome 1 (activities of ICRISAT) under sub-activity MA1111-17 and sub-activity MA1123-17 of IER on sheep fattening.

Outcome 3	Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies.
a. Output 3.2:	Improved policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are developed.
b. Activity 3.2.1:	Identify constraints to and opportunities for improving access to the output and input markets by women and youth in the target area.
c. Sub-activity MA3211-17:	**Assess value chain constraints and opportunities for male, female and young farmers in the Koutiala district.**

d. Research team

Name	Institution	Role
Katrien Descheemaeker	Wageningen University	Activity leader – student supervisor
Jeroen Groot	Wageningen University	Activity co-leader
Ken Giller	Wageningen University	Student supervisor
Arouna Bayoko	AMEDD	Collaborator

e. Student(s)

Name	Institute	Degree	Start	End
Arouna Dissa	IER & WUR	PhD student	Jan. 2017	Dec. 2020

f. Location(s)	Koutiala
g. Start	July 2017
h. End	February 2018

1. Justification
Adoption of sustainable intensification technologies is often constrained by limited access to markets. Different actors in the value chain run considerable risks and do not make use of the existing potential due to limited interactions and insufficient trust between them. To design better functioning value chains, in which male, female and young farmers can achieve the potential of sustainable intensification, a first step is a better understanding of how current value chains function, and where the major constraints and opportunities are.

2. Objectives
2.1 To understand the functioning of value chains in the Koutiala area, including the various actors and the interactions between the latter
2.2 To diagnose transaction costs at various points in the value chains
3. Research questions
3.1 What are the major constraints and opportunities for male, female and young smallholder farmers in terms of accessing and benefiting from value chains in the Koutiala district
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1. Survey of actors in at least three relevant value chains in the Koutiala district Previous work in a related project on agro-ecological intensification in the Koutiala district (funded by McKnight Foundation, and led by WUR) identified maize, groundnut, milk and small ruminant value chains to be important in the region. In this activity, the key actors upstream and downstream from the producers will be mapped and information on activities, costs and prices will be collected from each of them. The type and number of actors to be surveyed might depend on the value chain, but we anticipate that input suppliers (e.g. for fertilizer and seed), milk cooperatives, sheep traders, veterinary service providers, fodder suppliers, will be important for the above-mentioned value chains. In the Koutiala district, it is possible that different actors of these types are active in the value chain, and in that case, we will try to sample and survey at least 2 or 3 actors per type.
4.2 Inclusion of male, female and young farmers as producers in the value chain analysis Not only household heads, but also other (including female and young) farmers will be included as producers in the value chain analysis.
4.3 Transaction costs analysis and social network analysis For each of the value chain actors, their interactions with other actors will be described and fed into a social network analysis. For each interaction, qualitative information on the relation between actors and the perceived risk will be captured through individual interviews. The transaction costs incurred and profit made for each of their activities will be quantified.

5. Data to be collected and uploaded	Responsibility/Institute
5.1. Commodity prices	Wageningen University
5.2. Investments, revenues, profits realized by different value chain actors	Wageningen University
5.3. Nature and frequency of interactions between value chain actors	Wageningen University

6. Milestones		
Deliverables	Means of verification	Date
6.1. PhD proposal	Proposal submitted and uploaded on Africa RISING Wiki page	Jul. 2017
6.2. Inventory of actors and institutions	Report submitted to ICRISAT and uploaded on Africa RISING Wiki page	Dec. 2017
6.3. Value chain assessment	Report submitted to ICRISAT and uploaded on Africa RISING Wiki page	Feb. 2018

7. Sustainable intensification indicators	
7.1 Productivity	
7.2 Environmental	

7.3 Economic	Higher percent of income coming from agriculture, production sold, and of land under cash crops at household level
7.4 Social	A higher number of households participating in cooperative marketing at district level
7.5 Human	

8. How will scaling be achieved?
Well-functioning markets and value chains may be a driver for the adoption of sustainable intensification practices. A better understanding of the current functioning and bottlenecks in value chains will identify entry points for improvement, which may foster widespread adoption. By involving different types of farmers and gender groups, we intend to be inclusive and not just focus on the well-endowed farmers with better access to markets.
9. How are the activities in this protocol linked to those of others?
The activities link closely with the other activities in outcome 3. Information on policies and institutions in activity MA311 will help to understand the broader context in which markets and value chains function in southern Mali. Activity MA321. led by IER will focus specifically on access to markets by women and youth and will complement our work in which we want to map the networks and the transaction costs involved in value chains.

Outcome 3	Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies.
a. Output 3.2:	Improved policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are developed.
b. Activity 3.2.1:	Identify constraints to and opportunities for improving access to the output and input markets by women and youth in the target area.
c. Sub-activity MA3212-17:	**Identify constraints and opportunities for improving access to markets for women and youth.**

d. Research team

Name	Institution	Role
Ousmane Sanogo	IER, Sikasso	Collect data and conduct technical analysis
Felix Badolo	ICRISAT	Contribute to data collection and technical analysis
Louis Dena	IER, Sikasso	Contribute to data collection

e. Student(s)

Name	Institute	Degree	Start	End
To be identified	IER	MSc	May 2017	Oct. 2017

f. Location(s)	Koutiala and Bougouni
g. Start	March 2017
h. End	January 2018

1. Justification

Women and youth represent the most important part of the Malian population. They actively participate in the production activities and improvement of household incomes. However in the society, because of some socio-cultural considerations, women's and youth's access to the market of some products (market of improved seed, fertilizers, cattle, chicken, cotton, etc.) is still difficult. In addition to that, little data is available on constraints and opportunities for improving access to markets for women and youth. To understand this situation, this study was initiated.
2. Objectives
2.1 Provide updated information and fill the gap on constraints and opportunities for improving access to markets for women and youth.
3. Research questions
3.1 What are the current constraints and opportunities for improving access to markets for women and youth?
3.2 Are there policies supporting and or inhibiting access to the markets?
3.3 What practices and institutional arrangement can support or constrain equitable access to markets and inputs?;
3.4 When identified policies and institutional arrangements are in support of market and inputs access, who supports and how?
3.5 How do those who access the market and inputs again access, what makes it possible?
4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.).
4.1 Survey and group discussion regarding the constraints and opportunities for women and youth to access to the markets. A questionnaire will be developed and issues related to access of women and youth to market will be asked. 40 people randomly selected will be interviewed. For the choice of 40 people, 20 will be selected in the Koutiala and 20 in Bougouni.

5. Data to be collected and uploaded	Responsibility/Institute
5.1 Secondary data	IER
5.2 Survey data	IER

6. Milestones

Deliverables	Means of verification	Date
6.1 Report on constraints and opportunities for improving access to markets for women and youth are identified.	Report and MSc thesis uploaded on Africa RISING West Africa Wiki page	Sep. 2017
6.2 Report on analytical analysis of constraints and opportunities to improve access to production assets and markets	Research paper submitted	Nov. 2018

7. Sustainable intensification indicators

7.1 Productivity	Not applicable
7.2 Environmental	Not applicable
7.3 Economic	Not applicable
7.4 Social	Not applicable
7.5 Human	Not applicable

8. How will scaling be achieved?
Scaling up will be achieved through partnership with development services. Dissemination strategies will include: development of communication materials such as posters for extension agents and farmers, and policy brief for policymakers. Organize stakeholder meetings with policymakers, farmers and extension officers on the results of the study.
9. How are the activities in this protocol linked to those of others?
Activities have links with those on outcome 1 under sub-activity MA1114-17 and also with sub-activity MA3211-17.

8. Budget (US$)				
Outcome/Output/Activity	Sub-activity	Budget Line	WUR	IER
Outcome 3/Output 1/Activity 1	MA3111-17	Personnel		3,000
		Services		3,000
		Supplies		500
		Capital		
		Travel		3,500
		Overhead		1,500
		Total		11,500
Outcome 3/Output 2/Activity 1	MA3211-17	Personnel	3,000	
		Services	2,500	
		Supplies	500	
		Capital		
		Travel	1,500	
		Overhead	1,125	
		Total	8,625	
Outcome 3/Output 2/Activity 1	MA3212-17	Personnel		3,000
		Services		3,000
		Supplies		500
		Capital		
		Travel		3,500
		Overhead		1,500
		Total		11,500
		Sub total	8,625	23,000
		Grand total	31,625	

Outcome 4: Effective partnerships to ensure delivery and large-scale uptake of SI technologies and practices are established with farmers, local communities, and research and development partners in the private and public sectors.

a. Output 4.1:	Understanding of the social, economic, and institutional constraints to and opportunities for technology adoption from different farm typologies improved.
b. Activity 4.1.1:	Map and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling delivery of validated technologies
c. Sub-activity MA4111-17:	Consolidating existing platforms, concurrently leading multi-stakeholder platform meetings at the village level and lead the organization of farmer to farmer exchange visits.

d. Research team

Name	Institution	Role
Oumar Samake	AMEDD	Activity leader
Arouna Bayoko	AMEDD	Workshop facilitator
Pierre Coulibali	AMEDD	Report production

e. Student(s)

Name	Institute	Degree	Start	End
Aboubacrine Maiga	Graduate Institute of International and Development Studies/Geneva	MSc	Apr. 2018	Feb. 2019

f. Location(s)	Koutiala and Bougouni
g. Start	March 2017
h. End	December 2017

1. Justification

From 2014 to date, six platforms have been established as part of Africa RISING project in Koutiala and Bougouni districts. These platforms, which bring together researchers, government technical services, NGOs and producers, held several meetings to discuss research protocols, challenges related to the activities implementation, engagements of local community and results of research activities. The consolidation of these platforms will stimulate the appropriation of the project activities by the state extension services and local farmers. These platforms will form the backbone of the large-scale dissemination strategy of proven technologies.

2. Objectives

2.1 Facilitate and provide multi-stakeholder interest group meetings, and identify scalable technologies and implementing partners

2.2 Provide support to other parallel platforms and to create synergies and facilitate technology adoption. The aim of this is to create synergies between the different platforms. For example, the link between the platforms created by Africa RISING Phase 1 and others working on similar issues such as livestock, cowpea, etc., should be addressed.

2.3 Organizing inter-farmers visits to develop farmers' perception on technology adoption

3. Research questions

3.1 How can platforms be used as a tool for large-scale dissemination of proven technologies in the context of Malian governance and decentralization system?

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)
4.1 Conduct an analysis of the players of the different platforms. This includes mapping and characterizing all of the existing platforms across the region to identify opportunities for platform-based scaling. The work was initiated previously by ICRAF and was limited to the intervention communes of Africa RISING. Presently there is a need to extend the analysis to a wider region where Feed the Future program is intervening for appropriate scaling strategy and to reach a large number of beneficiaries.
4.2 Organize two training sessions for members of existing platforms The training needs of the actors will be identified and prioritized during the first platform meetings. The two priority topics will be the subject of the training sessions.
4.3 Facilitate the quarterly meetings of the said platforms
4.4 Organize exchange visits between platforms

5. Data to be collected and uploaded	Responsibility/Institute
5.1 The categories of actors involved in the platforms, their strength and weakness	Arouna Bayoko/AMEDD
5.2 Number of actors trained	Arouna Bayoko/AMEDD
5.3 Number of meetings and visits held	Arouna Bayoko/AMEDD

6. Milestones		
Deliverables	Means of verification	Date
6.1 Report on platform analysis	Report uploaded on Africa RISING West Africa Wiki page	Aug. 2017
6.2 Report on exchange visit	Report uploaded on Africa RISING West Africa Wiki page	Dec. 2017
6.4 Report on strengths and weaknesses of the platforms in the dissemination of technologies and the monitoring of adoption are established	Report and MSc thesis uploaded on Africa RISING West Africa Wiki page	Dec. 2019

7. Sustainable intensification indicators	
7.1 Productivity	Farmers' perception of yield variation (discussion of why field yields vary, list of rank causes) at farm level
7.2 Environmental	
7.3 Economic	Percentage of production sold (by crop, animal product), percentage of total income from agriculture at farm level
7.4 Social	Number of problems addressed by innovation platform, number of active innovation platforms at village level
7.5 Human	

8. How will scaling be achieved?
As this activity is concerned with platform meetings and information sharing, it uses the information concerning technological practices for wider dissemination using different forums.
9. How are the activities in this protocol linked to those of others?
The platform meeting is linked to all activities presented in the current work plan.

Outcome 4:	Effective partnerships to ensure delivery and large-scale uptake of SI technologies and practices are established with farmers, local communities, and research and development partners in the private and public sectors.
a. Output 4.4:	Knowledge sharing centers and learning alliances within existent local and regional institutions including development actors developed.
b. Activity 4.4.1:	Establish knowledge-sharing and learning alliances among scaling actors.
c. Sub-activity MA4411-17:	Operation of four technology parks as hubs for research and dissemination in Bougouni and Koutiala

d. Research team

Name	Institution	Role
Birhanu Zemadim	ICRISAT	Leader and scientist on land and water
Ramadjita Tabo	ICRISAT	Agronomist
Felix Badolo	ICRISAT	Economist
Baloua Nebie	ICRISAT	Breeder and scaling expert
John Nzungize	ICRISAT	Scaling expert
Mahamadou Dicko	ICRISAT	Bougouni site coordinator
Karamoko Traore	ICRISAT	Koutiala site coordinator
Salmoye Coulibaly	ICRISAT	Administrative assistant
Kalifa Traore	IER	Soil and Water Scientist
Jean-Baptiste Tignegre	WorldVeg	Agronomist/Breeder
Oumar Samake	AMEDD	Koutiala multi-stakeholder facilitator
Tumaini Sidibe	FENABE	Bougouni multi-stakeholder facilitator
Goussou Diarra	CAAD	Scaling on proven groundnut technologies in Koutiala
Fousseni Dembele	GRADCOM	Scaling on proven groundnut technologies in Bougouni

e. Student(s)

Name	Institute	Degree	Start	End
Diakarida Goita	IPR/IFRA Katibougu	BSc	Oct. 2017	Jun. 2019
Yaya Traore	IPR/IFRA Katibougu	BSc	Oct .2017	Jun. 2019

f. Location(s)	Bougouni and Koutiala districts
g. Start	March 2017
h. End	February 2018

1. Justification:

Mali Africa RISING project is coordinated by ICRISAT in close collaboration with partner institutes. Four technology parks were established, two in Bougouni (Flola and Diaba villages), and two more in Koutiala (M'Pessoba and N'Golonianasso villages). These parks have been used by participating institutes (ICRISAT, ICRAF, WorldVeg and IER) to conduct controlled research experiments. Training programs have been conducted in the parks for local NGOs, national training centers and communities living in Africa RISING intervention villages. The parks have been used by other programs as well, like the West Africa sorghum improvement program,

groundnut improvement program for capacity building and outreach activities. In addition, the establishment of the parks has integrated the research and capacity building activities by the different project partners. From phase I of the program it was understood that long-term sustainability of running innovation platforms was not very likely. In this case, the four technology parks will be used to conduct multi-stakeholder interest group meetings while the consolidation of existing platforms as explained in MA4111-17 would help to map and assess different actors for scaling delivery of validated technologies. The end goal would be to formalize the four parks as unique community level multi-stakeholder platforms for all programs conducted in the specific commune. The activities in the parks have been supervised by site coordinators and logistically equipped with pickup cars and drivers.

2. Objectives

2.1. Conducting integrated and multi-disciplinary research on sustainable intensification program

2.2. Developing a research hub for validating Africa RISING technologies for wider dissemination, providing capacity building and short-term training programs

2.3. Provide a site for multi-stakeholders interest group meetings

2.4. Provision of information concerning proven technological practices and climate services

2.5. Provision of high-quality agricultural inputs (plant material, fertilizer etc.), and climate-smart water access facilities

3. Research questions

3.1. None

4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.)

4.1. The four technology parks will be utilized by the research team under the supervision of the two site coordinators. At each site, scientists and implementing partner institutes will identify and determine the size of the field plot to implement the field trials. Training programs will be provided to participating farmer groups on the introduced technology prior to activity implementation. With the use of these technology parks and independently identified farmers' fields, and according to the phase II proposal we are expecting to reach 2,011 households through research and capacity building activities. Identified best-bet technologies would be scaled to approximately 9,500 households through development actors who are working with Africa RISING program. The socio-economy group will monitor the adoption of identified technologies in farmers' fields and conduct continuous monitoring and evaluation. In each technology park, a farmer field day will be organized to bring farmers together and create an opportunity to discuss the types of technologies introduced, the relevance and challenges among the farmer groups.

5. Data to be collected and uploaded	Responsibility/Institute
5.1. All field trial data that include agronomic, and land, soil and water management	ICRISAT
5.2. All data related to training and farmers field visit	ICRISAT

6. Milestones

Deliverables	Means of verification	Date
6.1. Biophysical database on improved technological practices and participatory research in the technology parks	Implemented trials, data uploaded on Dataverse	Dec. 2017

6.2. Types of technologies disseminated, capacity building, farmers' field visit and video demonstration	Interim and final reports to IITA	Dec. 2017

7. Sustainable intensification indicators	
7.1 Productivity	N/A
7.2 Environmental	N/A
7.3 Economic	N/A
7.4 Social	N/A
7.5 Human	N/A

8. How will scaling be achieved?
The technology parks are the sites for technological innovation, demonstration and capacity building. Best-bet technological innovations will be scaled-up to farmers fields through farmers exchange visits and implementation of trials at farmers field. Hence technology parks are considered as ideal sites where scaling works start.
9. How are the activities in this protocol linked to those of others?
The proposed crop-livestock activities in the current work plan were previously implemented in the technology parks.

8. Budget (US$)							
Outcome/Output	Sub-activity	Budget Line	ICRISAT	AMEDD	CAAD	GRADCOM	FENABE
Outcome 4/Output 1/Activity 2	MA4121-17	Personnel		5,000			
		Services		7,500			
		Supplies		3,500			
		Capital					
		Travel		4,000			
		Overhead		3,500			
		Total		23,000			
Outcome 4/Output 4/Activity 1	MA4411-17	Personnel	21,8610		4,500	4,500	5,000
		Services	9,410		3,000	3,000	3,000
		Supplies	54,000		500	500	500
		Capital					
		Travel	2,500		2,000	2,000	6,500
		Overhead	42,600		1,500	1,500	2,250
		Total	327,200		11,500	11,500	17,250
		Sub total	327,200	23,000	11,500	11,500	17,250
		Grand total	390,950				

Consolidated budget

Activity protocol	Leader	ICRISAT	ILRI	IER	WORLDVEG*	WUR	AMEDD	FENABE	CAAD	GRAADCOM	Total
Outcome 1: Productive, resilient and sustainable crop-livestock systems											
Integrated crop-livestock production	ICRISAT	28.8	46	28.750		8.635	23				135.185
Scaling out climate Information Services (CIS)	ICRISAT	23.0									23.0
Water resources management	IER	11.5		17.3							28.8
Land and soil resources management	ICRISAT	46.0		11.450			17.250				74.7
Economic and gender study on technologies	ICRISAT	23.0					11.5				34.5
Outcome 2: Improved nutrition, food safety, postharvest handling and value addition											
Nutrition-sensitive-agriculture options in Mali	ILRI		120.261		94.08		17.250				231.591
Outcome 3: Enabling policies and institution for equitable access to production assets and markets											
Farming systems	WUR			23.0		8.625					31.625
Outcome 4: Partnerships to ensure delivery and uptake of sustainable innovations at scale											
Research for Development Platforms	AMEDD						23.0				23.0
Technology parks management	ICRISAT	327.2						17.250	11.5	11.5	367.45

Sub-total		459.5	166.261	80.5	94.08**	17.260	92	17.250	11.5	11.5	949.85.1
Grand total										949.85.1	
*WorldVeg budget will be handled by IITA, **OH cost calculated for WorldVeg is at 17.6% (the institutional OH), hence WorldVeg is to be awarded a total of $USD 94.1 for the 2017/2018 work plan.											

Feed the Future and Custom Indicators

Indicator code	Feed the Future or Custom	FY 2017 Target
4.5.2(42): (4.5.2-28)	Number of for-profit private enterprises, producers' organizations, water users' associations, women's groups, trade and business associations and community-based organizations (CBOs) that applied improved organization-level technologies or management practices with USG assistance	**83**
	Type of organization	
	Private enterprises (for profit)	5
	Producers organizations	46
	Water users' associations	0
	Women's groups	24
	Trade and business associations	6
	Community-based organizations (CBOs)	2
	Disaggregates Not Available	0
	New/Continuing	**83**
	New	34
	Continuing	49
	Disaggregates Not Available	0
4.5.2(2)	Number of ha of land under improved technologies or management practices with USG assistance	**1178.45**
	Technology type	0
	crop genetics (maize, p'pea, sorghum, bambara, g/nut, livestock forages)	307.8
	pest management	74.8
	disease management (MLN)	4.8
	soil-related	9.3
	irrigation	0.75
	water management	707.5
	climate mitigation or adaptation	73.5
	other	0
	total w/one or more improved technology	0
	Disaggregates Not Available	0
	New/Continuing	**1178.45**
	New	1020.65
	Continuing	157.8
	Disaggregates Not Available	0
	Sex	**1178.45**
	Male	561.8
	Female	616.65
	Joint	0
	Association-applied	0
	Disaggregates Not Available	0
EG.3.2-1: (4.5.2-7)	Number of individuals who have received USG-supported short-term agricultural sector productivity or food security training	**1293**
	Type of individual	4

	Producers	1129
	People in government	84
	People in private sector firms	35
	People in civil society	45
	Disaggregates Not Available	0
	Sex	**1293**
	Male	649
	Female	644
	Disaggregates Not Available	0
4.5.2(11):	Number of food security private enterprises (for profit), producers organizations, water users associations, women's groups, trade and business associations, and community-based organizations (CBOs) receiving USG assistance (RIA) (WOG)	**88**
	Type of organization	0
	Private enterprises (for profit)	9
	Producers organizations	35
	Water users associations	2
	Women's groups	28
	Trade and business associations	10
	Community-based organizations (CBOs)	4
	Disaggregates Not Available	0
	New/Continuing	**88**
	New	27
	Continuing	61
	Disaggregates Not Available	0
EG.3.2-17: (4.5.2-5)	Number of farmers and others who have applied improved technologies or management practices with USG assistance	**2683**
	New/Continuing	
	New	2364
	Continuing	319
	Disaggregates Not Available	0
	Sex	**2683**
	Male	1694
	Female	989
	Disaggregates Not Available	0
4.5.2(12):	Number of public-private partnerships formed as a result of FTF assistance	
	Agricultural production (NAFAKA)	5
	Agricultural post harvest transformation	30
	Nutrition (Tuboreshe Chakula?)	10
	Multi-focus	12
	Other	0
	Disaggregates Not Available	0
EG.3.2-x27: (4.5.2-27)	Number of members of producer organizations and community-based organizations receiving USG assistance (S)	**50**
	Type of organization	0
	Producers' organization	40
	Non-producer-organization CBO	10
	Disaggregates Not Available	0

	Sex	**50**
	Male	30
	Female	20
	Disaggregates Not Available	0
(4.5.2(42): (4.5.2-28).	Number of private enterprises (for profit), producers organizations, water users associations, women's groups, trade and business associations, and CBOs that applied improved technologies or management practices as a result of USG assistance	68
	Type of organization	0
	Private enterprises (for profit)	0
	Producers organizations	20
	Water users associations	12
	Women's groups	11
	Trade and business associations	3
	Community-based organizations (CBOs)	14
	Disaggregates Not Available	8
	New/Continuing	**68**
	New	34
	Continuing	34
	Disaggregates Not Available	0
4.5.2(39):	Number of technologies or management practices in one of the following phases of development: (Phase I/II/III) (S)	
	Phase 1 Number of new technologies or management practices under research as a result of USG assistance	35
	Phase 2 Number of new technologies or management practices under field testing as a result of USG assistance	19
	Phase 3 Number of new technologies or management practices made available for transfer as a result of USG assistance	8
	Number of children under 2 (0-23 months) reached with community-level nutrition interventions through USG-supported programs	700
	Male	332
	Female	368
	Number of individuals receiving nutrition-related professional training through USG-supported programs	682
	Male	222
	Female	460
1	Number of community-based, regional and national networks and partners established to exchange knowledge and information.	15
2	Number of on-farm demonstrations established	157
3	Number of field days organized	2
4	Number of youth and women participating in project activities	697
5	Youth	342
6	Women	355
7	Number of households using climate information or implementing risk-reducing actions to improve resilience to climate change	85
8	Number of guidelines and training materials developed by AR researchers? Maybe disaggregate by topic of training	5
9	Number of graduate (MSc and PhD) students trained as part of AR	10
10	PhD	4

11	New	4
12	Continuing	0
13	MSc	2
14	New	2
15	Continuing	0
16	Number of AR project reports produced	8
17	Number of AR-based journal papers published	1
18	Number of posters, policy briefs, leaflets and films produced by AR researchers	4
19	Number of radio and TV discussions organized by AR researchers	1
20	Number of households benefiting from nutrition intervention due to AR	810
21	Percent change in dietary diversity score of farm household in the project intervention communities.	10.1
22	Number of households, especially women with access to home or community garden due to AR	125
23	Number of women and youth participating in production and marketing decisions as a result of AR	110
24	Youth	60
25	Women	50
26	Percent aflatoxin reduction at harvest through use of aflasafe in the field	0
27	Number of published guidelines on market opportunities and market niches	2
28	Number of community-based producers' organizations established and/or strengthened for production, processing and marketing.	23
29	Number of households clustered to viable value chains by type of market orientation	100
30	Number of agricultural and nutritional enabling policies, regulations and administrative procedures recommended and communicated by AR researchers	0
31	Number of knowledge sharing centers and learning-alliances developed AR researchers within existing local and regional institutions.	8
32	Number of people trained in CSA including PICSA approach.	200
33	Number of farmers using climate information in their decision-making	200